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Expectancy-value appraisals and achievement emotions in an online learning environment: Within- and between-person relationships

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ABSTRACT

Motivation and emotion are of critical importance for students' academic learning and achievement. Drawing on Eccles and Wigfield's situated expectancy-value theory and Pekrun's control-value theory, we examined to what extent specific expectancy-value appraisals related to students' achievement emotions. We collected intensive state data of $N = 95$ university students over one semester in an online learning environment. Students' appraisals were analyzed on different aggregation levels in a hierarchical design, which accounts for variability within learning situations and between students. Our results corroborated theoretical assumptions that expectancy-value appraisals are positively associated with positive emotions and negatively with negative emotions. However, we found that students experienced positive emotions in learning situations of high intrinsic and utility value, but not in situations of high attainment value. Examining appraisal combinations and discrete emotions, we found that particularly students' perceived costs moderated the relationship between expectancy and frustration and boredom on the situation level.

1. Introduction

Motivation and emotion are essential for students' engagement and learning in classroom and achievement-related outcomes according to Pekrun's control-value theory (CVT; Pekrun, 2006) and Eccles and Wigfield's situated expectancy-value theory (SEVT; Eccles & Wigfield, 2020). While CVT focuses on achievement emotions, SEVT puts the emphasis on the prediction of achievement-related choices. Both theories suggest that expectancies and values are central forces in predicting motivation and emotions. Combining assumptions from both models, we analyzed the role of expectancy and value appraisals in university students' achievement emotions (enjoyment, hope, frustration, and boredom).

To our knowledge, only few studies have used SEVT's task values in association with students' achievement emotions (see Kiuru et al., 2020; Lauermann et al., 2017), but there are no studies that also have included the negative cost value facet. Our study adds to the literature in that we operationalize the value component in line with Eccles et al. as intrinsic, utility, attainment, and cost value. This differentiated assessment has proven to be useful in predicting activity choices, enrollment decisions, persistence, and effort (Cole et al., 2008; Dietrich et al., 2017; Durik et al., 2006; Wigfield et al., 2015), while to date it has remained unknown if, for example, utility value is emotionally relevant in the same way as intrinsic value.

Both CVT and SEVT highlight the situation-specificity of emotions and expectancy-value appraisals (cf. the new name situated expectancy-value theory; Eccles & Wigfield, 2020). Compared to inter-individual between-person differences, to date, very little is known about situational processes involving expectancies and values, and achievement emotions (e.g., Bieg et al., 2013; Dietrich et al., 2017). Our study builds on a growing body of research examining both levels of analysis: the intra-individual, within person level of motivational-emotional states in specific learning situations, and the inter-individual, between person level reflecting trait appraisals of expectancy and value, and trait emotions.

Finally, we examined whether combinations of appraisals are associated with specific emotions, which, although integral part of the theoretical propositions, still remains underexplored (see Kögler & Göllner, 2018).

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1.1. Current expectancy-value models of achievement motivation and emotions

Pekrun's (2006) CVT describes achievement emotions along three dimensions: valence (positive vs. negative), level of physiological arousal (activating vs. deactivating), and object focus in terms of being related to either achievement activities (e.g., learning tasks) or achievement outcomes (i.e., success and failure) (Pekrun et al., 2002; Pekrun, 2006). In the present study, we included enjoyment, frustration, and boredom considered as activity-related emotions, and hope, which represents a prospective outcome emotion (i.e., hope for success). The selection of these emotions based on Pekrun's (2006) three-dimensional taxonomy of achievement emotions. We included all activity emotions with the exception of anger due to its conceptual similarity to frustration (e.g., they are negative activating emotions). Because we wanted to assess two positive and two negative emotions, we further included hope as an anticipatory emotion because it best suited the question of interest of our study (i.e., students' emotions during online learning activities in preparation to an upcoming exam). Achievement emotions are induced when a learner feels in control of, or out of control of, achievement activities and outcomes (i.e., the expectancy component) that are subjectively important (i.e., the value component) (Pekrun & Perry, 2014). In Appendix A https://osf.io/pmj2a/?view_only=f50c285b8b39438baebce45ff85d79a3(available at https://osf.io/pmj2a/) we offer an in-depth comparison and outline several overlaps of both theories.

The expectancy and value components in CVT and SEVT are conceptualized in similar ways. In the CVT, the expectancy-component is differentiated into *prospective control appraisals* referring to future events, and *retrospective control appraisals* referring to causal attributions (Pekrun & Perry, 2014). Similar to prospective control, Eccles and Wigfield (2020) define *expectancies for success* as individuals' beliefs about how well they will do on an upcoming task in the immediate or longer-term future. In this study we measured this latter belief with respect to an upcoming exam. Although both theories are underpinned by generalized competence beliefs, they are not identical (Putwain et al., 2018). While CVT has a broader conceptualization of prospective expectancy, SEVT's success expectancy is more narrow. However, both concepts reflect students' future-oriented ability beliefs.

The value component in CVT (Pekrun, 2006) consists of *intrinsic and extrinsic value,* while Eccles et al.'s SEVT offers a more refined conceptualization of values: *intrinsic* (the situational interest in a task, activity or subject), *attainment* (the personal importance of doing well on the task), *utility* (the instrumental usefulness for obtaining a desired goal), and *cost* value (cost of engaging in the activity). We selected one specific subfacet of utility value (i.e., utility for future job), assuming that it might be most relevant to our context of first year students attending a lecture on Educational Science because it relates to students' long-term (occupational) goals. Finally, the *cost value* refers to the negative aspects of engaging in a task. Our study focused on opportunity costs (i.e., the time lost to engage in other valued activities; Eccles & Wigfield, 2020), as this facet might be most relevant to our context of students engaging with online learning material in a self-directed manner.

SEVT's intrinsic, attainment, and utility value broadly align with the different types of subjective values proposed in CVT (intrinsic and various types of extrinsic) (see Putwain et al., 2018). For example, the *intrinsic value* of CVT partially overlaps with the intrinsic and attainment value of SEVT, as they address the relative personal/identity-based importance attached by individuals to engage in tasks or activities. Appraisals of CVT's *extrinsic value* refer to instrumental utility of activities or outcomes for the attainment of goals and thus overlaps considerably with the SEVT's utility value in the sense of capturing the more "extrinsic" reasons for engaging in a task (Eccles & Wigfield, 2020; Pekrun & Perry, 2014).

When taking a joint perspective on SEVT and CVT, the question arises as to whether Eccles and Wigfield's differentiation of various value facets matters in predicting different achievement emotions. It might be that utility value is crucial to reduce boredom but is less likely to co-occur with hope. It might also be that frustration more likely relates to high perceived costs than to low intrinsic value. Differences in the role of different value facets might also depend on the level of analysis (situation vs. person level). Prior findings suggest, for example, that there are more situational fluctuations in intrinsic value than in cost value (see Dietrich et al., 2017), indicating that some value facets are determined more by situational characteristics and others more by generalized dispositions. Furthermore, CVT and SEVT share similar propositions in terms of emotions and motivation, arising from multiplicative combinations of control/expectancy and value (see Putwain et al., 2018). Both theories assume that important achievement outcomes (e.g., effort, enjoyment) result from a combination of positive competence and value appraisals (Eccles & Wigfield, 2020; Pekrun & Perry, 2014), suggesting that both expectancy and value are necessary for an emotion to be instigated (Pekrun, 2006).

1.2. Empirical evidence on appraisal-emotion-links

Empirical findings concerning *expectancy appraisals* show that higher perceived control over activities is associated with higher levels of positive emotions such as enjoyment, hope or pride (Ahmed et al., 2010; Bieg et al., 2013; Frenzel et al., 2007; Goetz et al., 2010). In contrast, the perception of low controllability is related to negative emotions such as anger, hopelessness, anxiety, and boredom (Ahmed et al., 2010; Bieg et al., 2013; Lauermann et al., 2017; Pekrun et al., 2010). This applies also to self-paced online courses (Artino & Jones, 2012). Notwithstanding the reported linear relationships, the CVT in fact suggests curvilinear associations for hope and boredom. Some uncertainty, reflected in a moderate expectancy, will lead to hope (an inverted u-shaped relationship). But both very high and very low expectancy will lead to boredom (a u-shaped relationship), meaning that students will feel bored when being under- or over-challenged (Pekrun et al., 2010). Findings to date provide most empirical support for boredom in situations of low expectancy (Bieg et al., 2013; Kögler & Göllner, 2018; Pekrun et al., 2010).

Empirical evidence on *value appraisals* shows positive linear relationships with positive emotions (e.g., Goetz et al. (2010) for joy and pride), and negative relationships with negative emotions such as anger, anxiety, and boredom (e.g., Ahmed et al., 2010; Bieg et al., 2013; Pekrun et al., 2010). Particularly boredom occurs when learning activities do not offer any incentive value (Ahmed et al., 2010; Bieg et al., 2013; Pekrun et al., 2010). Studies of achievement emotions in online learning contexts show similar relationships between value appraisals and emotions, suggesting that findings are equally robust in online learning situations (Camacho-Morles et al., 2019; for an overview, see Daniels & Stupnisky, 2012). Research on frustration is scarce, but based on theoretical assumptions, frustration will arise when the value of the activity is negative (e.g., when engaging in a particular task is perceived as taking too much effort at the expense of other valued activities) (Pekrun, 2006, 2018). This corresponds to high opportunity cost sensu Eccles and Wigfield (2020). Finally, the experience of hope is expected to depend on expectancy rather than on value (Pekrun, 2006).

Beyond the linear relationships between appraisals and achievement-related behaviors and emotions, both CVT and SEVT propose interactive and quadratic relations between expectancy-value appraisals and achievement-related outcomes (Nagengast et al., 2011). Specifically, CVT postulates that the effects of expectancy vary depending on the extent to which an individual values a given activity or outcome, that is, the value moderates the relationship between expectancy and emotions. This means that *enjoyment* during learning will be enhanced when the task is both controllable and positively valued (Pekrun, 2006). Goetz et al. (2010) corroborated this assumption. It is further assumed that *hope* is related to moderate expectancies while concurrently the intrinsic value is high (e.g., the subject of the learning task is interesting) (Pekrun, 2006). To our knowledge, however, this has

not been tested yet. Moreover, CVT suggests that if a learning activity is not sufficiently controllable, regardless if it is positively or negatively valued, this corresponds with the experience of *frustration* (Pekrun, 2006, 2018). Findings of Putwain et al. (2018) support this for learning activities with positive value. Finally, according to CVT, *boredom* is highest when a lack of situational value occurs in concert with low expectancy. Bieg et al. (2013) found the following interaction effects: that students' expectancy related to the experience of less boredom when their value was concurrently high. But when their value was low, students experienced generally more intense boredom, regardless of their expectancy.ini

1.3. The present study

The present study examined the relationships between expectancy-value appraisals and university students' achievement emotions during online learning activities. For this reason, the study was embedded in an online learning environment with a complementary blended learning element of a weekly face-to-face lecture for first year students of Educational Science. As part of the learning environment, students could take learning tests on different levels of difficulty.

To gain a better understanding of the relationships between specific task value facets and students' emotional experiences, we combined theoretical assumptions of Pekrun's CVT with Eccles and Wigfield's SEVT. Thus, we assessed all four facets (intrinsic, attainment, utility, and cost) of the subjective task value component. Situational expectancy was operationalized as expected success in the exam. We focused on enjoyment and hope as typical positive emotions and on frustration and boredom as typical negative emotions.

We collected intensive state data and therefore were able to disentangle appraisal-emotion associations on the level of intra-individual states or situations (within students) from associations on the level of inter-individual differences in motivational-emotional dispositions (between students). This approach takes into account that results from between-person analyses can only be generalized to within-person findings when certain assumptions (i.e., population means, variances, and covariances are identical to the corresponding within-person moments) are met. Thus, it is generally necessary to disaggregate between- and within-person effects (Reitzle & Dietrich, 2019). Finally, we examined the moderating role of the task values in the expectancy-emotion link. In this case, due to the differentiated assessment of task values, the analyses offer new insights concerning the nature of the appraisal-emotion link.

Next, we describe our general hypotheses regarding *success expectancy* (*RQ1*), *subjective task values* (*RQ2*), and *expectancy-value interactions* (*RQ3*). Subsequently, the respective assumptions pertaining to the situation and the person level will be outlined.

RQ1 Success expectancy: To what extent does success expectancy relate to achievement emotions? We expected positive associations with *enjoyment* (H1a). We further hypothesized curvilinear relationships with *hope* (H1b) and *boredom* (H1d). Finally, we expected negative relationships with *frustration* (H1c).

RQ2 Subjective task values: To what extent do subjective task values relate to achievement emotions? We expected positive associations with intrinsic, attainment, and utility values and negative associations with cost value and *enjoyment* (H2a), but no associations with *hope* (H2b). Moreover, we hypothesized negative relationships between intrinsic, attainment, and utility values and *frustration*, but positive associations with cost value (H2c). Finally, we expected negative associations with intrinsic, attainment, and utility values and *boredom* (Pekrun et al., 2010; Pekrun & Perry, 2014) and positive association with cost value (H2d).

RQ3 Expectancy-value interactions: To what extent students' expectancy and achievement emotions are moderated by the task values? In line with previous findings (Goetz et al., 2010), we expected that *enjoyment* is highest when high expectancy is combined with either high intrinsic, attainment or utility value and with low opportunity cost (H3a). We further hypothesized that hope is highest when experiencing moderate expectancy together with high intrinsic, attainment, and utility values, and low cost value (H3b). *Frustration* was assumed to be highest when low expectancy combines with either high intrinsic, attainment or utility values (H3c) or with high cost (H3d). Based on theoretical assumptions and previous findings (Bieg et al., 2013; Kögler & Göllner, 2018), we finally expected that boredom is highest when low (rather than high) expectancy is combined with either low intrinsic, attainment or utility values (H3e) or with high cost (H3f).

Our general hypotheses apply to the situation level and the person level as follows. When using the example of frustration, the situation level pertained to specific learning tests that each student took and to frustration as an emotional state, whereas the person level pertained to a student's overall level of frustration, representing an emotional trait. On the situation level, we therefore expected that when students believed not be able to succeed in mastering the contents of a given learning test, or when they considered the task as too costly, they would feel frustrated after completing that learning test. On the person level, we hypothesized that students with generally lower levels of success expectancy would also be those who repeatedly experience highly frustrating situations.

2. Method

2.1. Sample and design

The study participants were 95 first-year German university students of the Bachelor program Educational Science, of which 75% ($n = 71$) were female. We used a short-term intensive longitudinal design. Participants completed online-assessments over the course of one semester (October to February 2018/2019) as part of an online learning environment, embedded in a blended learning course. The course ended with a written exam.

In the respective online learning environment (see Dietrich et al., 2021) students were offered learning tests with automatized feedback on varying levels of difficulty. Less complex learning activities consisted of simple questions with closed answer formats (e.g., single or multiple choice, drag and drop), whereas problem-based activities with higher complexity comprised of a vignette with several related questions and with closed response formats (e.g., multiple choice). The feedback in less complex activities involved students' total performance (points earned), knowledge of the solution for each question and knowledge of the correct answer. The feedback in more complex activities comprised elaborations about the key concepts addressed in each question, and explanations why the single answer options were correct or incorrect. For each out of 11 course topics (e.g., emotion, diagnostics, socialization, cognition) three learning tests (easy, medium, hard) were conducted, and one extra learning test for the introductory lecture. This resulted in $n = 34$ learning tests as the maximum number of time points that were possible per student. Students could choose learning tests based on teacher-defined but flexible criteria. This means that rather than being instructed to go through all learning tests, students could select learning tests depending on their pre-knowledge and interests. Students could qualify for an additional point for the exam, if they processed a total of 50% of all learning tests (17 out of 34 learning tests). Students completed $M = 15.75$ learning tests, resulting in a situation-level n of 1496 learning situations.

2.2. Measures

After completing a learning test and before displaying the performance feedback, students answered a situational motivation and emotion questionnaire with nine items (Appendix B). A tenth item, not used in the present study, measured students' effort. The situational motivation questionnaire consisted of five items measuring subjective task values and success expectancy and four items measuring

achievement emotions. The students were instructed to consider the learning contents of the test they just had completed. They were then prompted – "To what extent do the following statements apply to you in the present moment?" – and responded on a four-point Likert scale ranging from *1 = does not apply* to *4 = fully applies*. After answering the motivational items, students were asked – "After completing the learning test, how do you feel?" "I am …" (i.e., joyful, hopeful, bored, frustrated) – and they rated their emotional state on a four-point Likert scale ranging from *1 = not at all* to *4 = very strongly* (adapted from Goetz et al., 2014).

Situational expectancy was measured with one item addressing expectations of success for the final exam (Dietrich et al., 2017). Sample item: "I will be good at these contents [the contents of this learning test] in the exam". Dietrich et al. reported between-person correlations to a trait-measure of success expectancy in a pre- and posttest questionnaire ($r = 0.25/0.26$).

Situational task values were measured with four items addressing the facets of intrinsic value, attainment value, utility value for future job, and opportunity cost as a subfacet of cost value (Dietrich et al., 2017). Sample item: "It is important for me to know a lot about these contents" (attainment value). Dietrich et al. reported between-person correlations to a trait-measure of the task value facets in a pre- and posttest questionnaire (intrinsic value: $r = 0.23/0.56$; attainment value: $r = 0.47/0.64$; utility value: $r = 0.34/0.65$; opportunity costs: $r = 0.51/0.64$).

2.3. Analysis strategy

2.3.1. Within- and between-person analysis

Given the hierarchical structure of the data, we conducted multilevel analyses with situations (Level 1, $n = 1496$) nested in students (Level 2, $n = 95$). The principal advantage of multilevel analyses is the separation of relationships on different levels pertaining to both intra-individual (Level 1) and inter-individual comparisons (Level 2). In our hierarchical linear regression model, expectancy, values, the expectancy × value interaction terms ($n = 4$), and the squared expectancy for the curvilinear effects were entered to predict achievement emotions (see Regression Models in Appendix B). All predictor variables were grand-mean centered prior to performing the analyses with the product terms used to test for interaction effects (Enders & Tofighi, 2007). We ran separate models for each of the four emotions because a single model contained too many parameters to converge. For the significant effects we computed Effect sizes (ES) as follows (Marsh et al., 2009; Morin, Marsh, Nagengast, & Scalas, 2014; Tymms, 2004). ES is comparable to Cohen's d.

Situation level: ES_{within}

$$= Est_{within} * (2 * \sqrt{Var_{x,\ within}}/\sqrt{Var_{y,\ within}})$$

Individual student level: $ES_{between}$

$$= Est_{between} * (2 * \sqrt{Var_{x,\ between}}/\sqrt{Var_{y,\ within}})$$

2.3.2. Bayesian estimation

The regression models were estimated using Bayesian estimation in the M*plus* version 8.4 software program (Muthén & Muthén, 1998-2021) using a seed value of 09062021. Bayesian estimation is suitable for low sample sizes as it does not produce inadmissible parameter estimates such as negative variances (Hox et al., 2012). The posterior distribution was obtained using the Markov chain Monte Carlo (MCMC) methods, which is an iterative procedure to estimate the parameters (van de Schoot et al., 2015). We used the Gelman and Rubin convergence diagnostic with a stricter convergence criterion than the default setting: 0.001 instead of 0.05. In the first step, we ran four chains with a convergence criterion of .001 and specified a minimum number of 100,000 MCMC iterations (see Depaoli & van de Schoot, 2017). We then used the fbiterations option to increase the number of iterations by a factor of two to check convergence and to limit the increase of the PSR value. After inspecting all trace plots manually to check whether all chains converged to the same target distribution and whether all iterations were based on stable chains, we found some parameters with large spikes (e.g., the IxE interaction) on the between-level. These extreme values are responsible for unusually broad credibility intervals. In such cases, the methodological literature (van de Schoot et al., 2015; Zitzmann et al., 2021) recommends specifying proper prior distributions. Consequently, we implemented an inverse gamma (IG) distribution with hyperparameters (0.5, 0.5) for the group-level variance of the predictor variables. Zitzmann et al. (2021) showed that the IG distribution resulted to be very effective in reducing the mean squared error in small samples compared with Maximum Likelihood. This recommendation allowed us to reduce the spikes, resulting in narrower (and presumably less biased) intervals.

Bayesian exploration of the model fit can be done using Posterior predictive checking (e.g., Gelman et al., 2004). The posterior predictive p-value (PPP) of model fit can be obtained via a fit statistic *f* based on the usual Chi-Square test. An excellent-fitting model is expected to have posterior predictive p-values (PPP) of 0.5 and a confidence interval for the *f* statistic, which includes zero, indicating that the observed data are just as probable as the generated data. Our model fits were all acceptable (PPP-values between .242 and .255, see Table 2) with negative lower limits of the 95% confidence interval, indicating good fits (see Muthén et al., 2010). Further information about Bayesian multilevel regression is in Appendix B.

2.3.3. Missing data analysis

In our data, missing data existed on two levels: students could have left out single items when answering the questionnaire after each learning test (1–3% missing data within learning tests). These missing data points were imputed as part of the MCMC method, which creates multiple imputations by using simulations from a Bayesian prediction distribution for normal data. For entire learning tests (i.e., complete missings of measurements), data were not imputed. On average, students completed 15.75 out of 34 learning tests, resulting in the 1496 valid state-measures that could be used in the analyses. This equals 46% of the theoretically possible measurements (34 learning tests à 95 participants = 3230). This percentage could be expected based on the incentive criteria that allowed students to qualify for an additional point for the exam if they completed at least 17 learning tests. Therefore, the missing of 46% corresponds to the expected amount of processed tasks. Outputs and the dataset are available in the online supplement (Appendix B and C at https://osf.io/pmj2a/).

3. Results

Table 1 depicts the means, variances, and intraclass-correlations. Bivariate correlations of the expectancies, values, and emotions on the situation level (Level 1) and person level (Level 2) are depicted in the online supplement (Appendix B). Addressing our RQs, Table 2 contains the standardized beta coefficients and credibility intervals.

3.1. RQ 1 – success expectancy and achievement emotions

The results concerning *expectancy* showed linear, but no curvilinear relationships with emotions. We found that situations of high success expectancy related positively to the momentary experience of enjoyment and hope, and negatively to frustration. On the person level, students with overall higher expectancy levels were also those who more often reported hope. On both levels, we found no negative relationships between students' success expectancy and boredom.

The effect sizes (ES) of the significant results on the within-level were small (frustration = −0.142) to large (enjoyment = 0.661; hope =

Table 1
Descriptive statistics and intraclass-correlation-coefficients.

Item	Level 1	Level 2		
	Variance	Variance	ICCs	M
Expectancy				
Success expectancy	0.301	0.130	.301	2.730
Subjective task values				
Intrinsic	0.393	0.141	.264	2.793
Attainment	0.292	0.238	.449	2.994
Utility	0.329	0.204	.383	2.803
Cost	0.292	0.624	.681	2.288
Achievement emotions				
Enjoyment	0.311	0.261	.456	2.245
Hope	0.360	0.212	.371	2.406
Frustration	0.336	0.337	.501	1.788
Boredom	0.260	0.279	.518	1.751

Note: ICC = intraclass correlation. Level 1 = Learning situation level. Level 2 = Student level.

0.791) and on the between-level the ES for hope was large (1.082).

3.2. RQ 2 – task values and achievement emotions

Addressing RQ2, situations of high *intrinsic value* were positively associated with feelings of enjoyment and hope and negatively with feelings of frustration and boredom. On the person level, students who often experienced intrinsic value were also those to report less frustration and boredom. The ES of the significant results on the within-level were small (boredom = −0.229) to medium (frustration = −0.408; enjoyment = 0.417; hope = 0.455) and on the between-level the ES were large (boredom = −1.017; frustration = −1.539).

Regarding *attainment value*, no associations were found for enjoyment and hope on both levels. However, situations of high attainment value negatively related to frustration and boredom. The ES of the significant results on the within-level were small (frustration = −0.158; boredom = −0.226).

Situations of high *utility value* positively related to enjoyment and hope. No associations were found for frustration. But on the person level, students' utility value was associated with generally lower boredom. The ES of the significant results on the within-level were small (hope = 0.139; enjoyment = 0.222) and on the between-level the ES for boredom was large (−1.479).

Regarding *cost value*, no associations were found for enjoyment on either level. But in situations of high cost, students reported lower hope. Higher cost value further related to stronger negative emotions, i.e. higher on both levels. The ES of the significant results on the within-level were small (hope = −0.112; boredom = 0.263; frustration = 0.312) and on the between-level the ES were large (frustration = 0.830; boredom = 0.938).

3.3. RQ 3 – expectancy × value interactions

RQ3 addressed the moderating role of the task values in the expectancy-emotion link. We found two situation-level interactions, both involving cost value.

First, momentary costs moderated the relationship between expectancy and frustration (β = −0.073 [-0.123, −0.024]; Fig. 1). Simple slope analyses showed a negative relationship between expectancy and frustration at high (*+1 SD*) cost value (β = −0.147 [-0.228, −0.068]) and at average cost value (β = −0.076 [-0.140, −0.013]). No association was found for low (*−1 SD*) cost value (β = −0.004 [-0.085, 0.076]). These results are in line with hypothesis 3d that the highest frustration corresponded with high cost situations and low expectancy.

Second, momentary costs moderated the relationship between expectancy and boredom (β = −0.106 [-0.157, −0.053]; Fig. 1). Simple slope analyses showed a negative relationship between expectancy and boredom at high (*+1 SD*) cost value (β = −0.087 [-0.159, −0.015]), but a positive relationship between expectancy and boredom at low (*−1 SD*) cost value (β = 0.094 [0.021, 0.167]). No association was found for average cost value (β = 0.004 [-0.053, 0.061]). These results are in line with hypothesis 3f, as high cost situations combined with low

Table 2
Standardized beta coefficients (intervals in parentheses) for the achievement emotions. Bold coefficients are significantly different from zero.

	Level 1 (within)				Level 2 (between)			
	enjoyment	hope	frustration	boredom	enjoyment	hope	frustration	boredom
Intercept	–	–	–	–	3.607 [2.802, 4.473]	4.338 [3.511, 5.284]	2.843 [2.212, 3.512]	2.945 [2.321, 3.616]
Expectancy *(E)*	**.297 [.240, .350]**	**.394 [.346, .442]**	**-.072 [-.131, -.013]**	.005 [-.057, .065]	.322 [-.028, .657]	**.577 [.293, .835]**	.081 [−.252, .445]	.201 [−.122, .533]
Intrinsic (I)	**.189 [.127, .250]**	**.227 [.172, .281]**	**-.205 [-.267, -.139]**	**-.115, [-.180, -.047]**	.174 [-.368, .731]	.323 [-.085, .733]	**-.625 [-1.221, -.184]**	**-.471 [-1.011, -.031]**
Attainment (A)	-.014 [-.070, .043]	.029 [-.021, .079]	**-.076 [-.135, -.016]**	**-.111 [-.172, -.051]**	.300 [-.436, 1.062]	-.051 [-.621, .518]	0.464 [−.153, 1.368]	.371 [-.248, 1.092]
Utility (U)	**.105 [.046, .161]**	**.070 [.018, .120]**	-.042 [−.102, .017]	-.055 [−.117, .007]	-.110 [-.683, 439]	.001 [-.470, .457]	-.410 [-1.085, .109]	**-.546 [-1.126, -.053]**
Cost (C)	-.024 [-.072, .024]	**-.055 [-.097, -.012]**	**.156 [.106, .205]**	**.130 [.079, .182]**	-.048 [-.306, .226]	-.121 [-.334, .076]	**.369 [.096, .602]**	**.373 [.114, .604]**
Expectancy^2	−0.032 [-.091, .025]	−0.051 [-.102, .001]	0.001 [-.057, .062]	-.003 [-.065, .060]	.134 [-.497, .749]	-.094 [-.617, .429]	.000 [-.600, .691]	.043 [-.526, .715]
I x E	.046 [-.018, .112]	-.014 [−.073, .045]	.024 [−.045, .093]	.012 [−.061, .084]	-.142 [-1.760, 1.672]	-.285 [-1.535, 0.936]	-.701 [-2.620, .598]	-.548 [−2.177, .781]
A x E	-.007 [-.068, .054]	.031 [-.024, .086]	.041 [−.023, .106]	.061 [−.005, .128]	.279 [-1.312, 1.732]	.522 [-.551, 1.656]	.939 [−.225, 2.640]	.912 [-.271, 2.312]
U x E	.043 [-.021, .104]	.032 [-.023, .089]	-.009 [−.074, .058]	-.017 [−.085, .052]	-.116 [-.587, .330]	.093 [-.265, .461]	-.253 [−.677, .197]	-.384 [-.815, .062]
C x E	.026 [-.023, .074]	-.025 [-.067, .019]	**-.073 [-.123, -.024]**	**−0.106 [-.157, -.053]**	.171 [-.181, .530]	-.028 [-.318, .254]	.076 [-.275, .413]	.132 [-.197, .452]
R^2	0.239 [.201, .279]	0.388 [.347, .429]	.162 [.128, .197]	.103 [.074, .134]	.579 [.395, .732]	.741 [.587, .850]	.639 [.450, .804]	.679 [.490, .821]
Residual variance	0.761 [.721, .799]	0.612 [.571, .653]	.838 [.803, .872]	.897 [.866, .926]	.421 [.268, .605]	.259 [.150, .413]	.361 [.196, .550]	.321 [.179, .509]

Note. Model 1 = Enjoyment. Model 2 = Hope. Model 3 = Frustration. Model 4 = Boredom. Statistical Analysis: Hierarchical linear regression. Estimator: MCMC. Sample size: N = 95. Model fit for enjoyment was PPP = .254, and f (95% CI) = −33.780–71.362, for hope PPP = .242 and f (95% CI) = −32.800–68.112, for frustration PPP = .255 and f (95% CI) = −34.325–68.880, and for boredom PPP = .246 and f (95% CI) = −34.792–67.266).

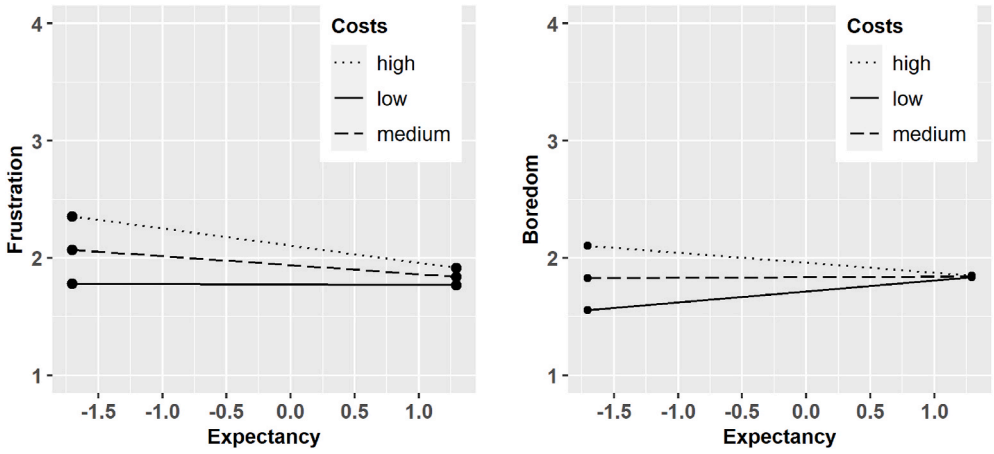

Fig. 1. Cost × Expectancy Interaction on Frustration and Boredom (within-person level). *Note.* Simple slopes for the interaction effects of expectancy and cost value on frustration (left panel) and boredom (right panel) found in Table 2.

expectancy related to a higher degree of momentary boredom. That high cost and high expectancy situations related to less boredom instead of more boredom was against our expectations. We did not find the hypothesized expectancy × value interactions for intrinsic, attainment, and utility value on enjoyment (H3a), hope (H3b), frustration (H3c), or boredom (H3e).

4. Discussion

The present study examined the relationships between expectancy-value appraisals and students' achievement emotions during online learning activities. We disentangled intra-individual effects pertaining to students in-situ experiences (within persons) from inter-individual effects pertaining to differences between students (between persons).

Overall, the findings of this study were in accordance with the theoretical assumption that expectancy-value appraisals are positively associated with positive emotions and negatively associated with negative emotions (Pekrun & Linnenbrink-Garcia, 2014). We found more associations within persons than between persons. Albeit we found no structural differences between the situation and person level regarding the direction of the appraisal-emotion links.

4.1. Appraisal-emotion links on the situation level

Consistent with our hypotheses H1a-c, learning situations that students perceived as controllable regarding anticipated success (high success expectancy) corresponded with higher enjoyment (H1a) and hope (H1b), and lower frustration (H1c). These findings corroborate the importance of measuring task- and time-specific expectancy beliefs in order to capture emotional experiences close to the situation.

Contrary to our hypothesis and previous studies which found negative associations on the situation level (see Bieg et al., 2013; Kögler & Göllner, 2018), we found neither squared nor linear effects of success expectancy on boredom (H1d). This discrepancy, particular with CVT, might be due to the different operationalizations of expectancy. While we measured expectancy as the probability of being successful in a future exam based on Eccles and Wigfield's SEVT, the other authors assessed perceived control retrospectively ("I have always done well in mathematics"; Bieg et al., 2013) or as the degree of time available to reflect on subject matter based on CVT (Kögler & Göllner, 2018). Furthermore, the non-existent associations between boredom and expectancy might also be due to floor effects in the experience of boredom, which indicates small variances in this particular emotion.

In line with our hypotheses H2a, H2c, and H2d supporting the predictions of CVT, situations of high intrinsic value consistently related to all achievement emotions. Consistent with findings showing that if individuals perceive a specific task as interesting, this corresponded with the experience of more positive and less negative emotions (Bieg et al., 2013; Goetz et al., 2010). Contrary to hypothesis 2b, the intrinsic value positively related to hope.

Furthermore, on the situation level, attainment value turned out to be negatively associated only with negative emotions, while utility value related exclusively to positive emotions. That is, when students perceived higher meaning of the learning contents in a particular learning situation, they experienced less frustration (H2c) and boredom (H2d), which is in line with the assumption that a misfit between learning contents and the individual's identity correspond with negative emotional experiences (see Eccles & Wigfield, 2020). In turn, when students perceived a higher usefulness for their future job, they experienced more enjoyment (H2a) and hope (H2b). This is in line with previous findings on utility value-interventions, showing that such interventions not only affect the perceived utility, but also the interest and task involvement in the learning contents (Gaspard, Dicke, Flunger, Brisson, et al., 2015; Harackiewicz et al., 2014). However, contrary to our theoretical assumption that there are no associations between task values and hope (H2b), we found significant links between intrinsic, utility, and cost value and hope. These results indicate that hope directly relates to the value, regardless ofexpectancy (Pekrun, 2006).

Taken together, these findings suggest that differentiating distinct task value facets in the context of achievement emotions is useful, because positive values such as attainment and utility value correspondend differently with discrete emotions. However, the explanations for these findings cannot be inferred from the present data. Future studies should systematically examine such mechanisms by means of qualitative study designs (e.g., interviews). Furthermore, our study was the first to show that highly costly learning situations go hand in hand with more frustration and boredom and less hope. These results might indicate that learning situations where students miss out other attractive activities become emotionally aversive. This corresponds with Eccles and Wigfield (2020) idea, that costly situations diminish students' engagement. Previous studies underline the fact that cost contributes negatively to students' motivational behavior, showing that the reason why students chose to participate or not in different activities (e.g., physical activity) was because of their perceived costs (Chiang et al., 2011; Watkinson et al., 2005).

4.2. Expectancy-Value Interactions on the situation level

In RQ3 we investigated to what extent students' expectancy and achievement emotions were moderated by the task values. We found expectancy × cost interactions on frustration (H3d) and boredom (H3f), both on the situation level. First, expectancy related to frustration only

in situations with high or medium but not low perceived costs. As predicted by CVT, this finding suggests that if students negatively value a particular learning situation, this might intensify their experience of frustration when they do not expect to be successful dealing with these contents in the exam (see Goetz et al., 2010; Lauermann et al., 2017). Second, our findings were in line with the prediction that when students experience low expectancy and negative value (i.e., high cost) simultaneously during a given learning task, they are most likely to be bored.

However, the expectancy × cost interaction on boredom can be interpreted in two ways. One construal is that in negatively valued (high cost) situations an over-challenge (low expectancy) increases the experienced boredom, while in low cost situations, the same is true for the under- or just-right challenge (high expectancy). Here, cost value moderates the effect of expectancy on boredom (see Bieg et al., 2013; Putwain et al., 2018; for other achievement-related behaviors see also Barron & Hulleman, 2015; Guo et al., 2016), as depicted in Fig. 1. Another construal is that perceived costs only increase boredom when students think they cannot master the learning contents, while at high expectancy levels it is irrelevant how costly a learning task is. Here, expectancy moderates the effect of value on boredom.

In light of this, our results indicate that high expectancy might potentially buffer the association between high cost and frustration and boredom. Which interpretation holds, or if even past emotional experiences impacted the expectancy-value appraisals by intensifying or mitigating subsequent appraisals, cannot be inferred from the present data. Moreover, when interpreting our findings, it needs to be taken into account that the negative emotions ranged below the scale midpoint, meaning that students rarely experienced strong frustration or boredom when taking the learning tests.

4.3. Appraisal-emotion links on the person level

Moving to the person level, we found that students' aggregated success expectancy only related to hope (H1b), although we expected that an individual's expectancy would relate to all achievement emotions. As we assessed hope with a different object focus (i.e., outcome-related) compared to the other emotions (i.e., activity-related), it is plausible that activity emotions close to the situation are more strongly determined by characteristics of the learning task (e.g., task difficulty) than by personality traits reflected in the aggregated person-level parameters. These findings underline the need of differentiating discrete achievement emotions beyond whether they are positively or negatively valenced.

The overall pattern on the person level in terms of intrinsic and cost value was similar to that on the situation level. In line with our hypotheses and prior research (Bieg et al., 2013; Pekrun et al., 2010; Pekrun, 2018), students with high intrinsic value tended to experience fewer frustrating (H2c) and boring (H2d) situations. Furthermore, as predicted, students who repeatedly experienced negatively valenced situations (i.e., high costs) also tended to experience more frustration (H2c) and boredom (H2d). In contrast to the situation level, our findings showed that students who repeatedly experienced a lack of usefulness of learning contents (i.e., low utility value) experienced more boredom, indicating that such situations might increase the likelihood of students' dispositional boredom in the long term. This finding was consistent with our hypothesis 2d and prior research on dispositional utility value (see Hall et al., 2016). Finally, contrary to hypothesis 2a (enjoyment), but in line with hypothesis 2b (hope), we could not observe any positive associations with students' intrinsic, attainment, and utility values and positive emotions on the person level. These findings indicate that concurrent in-the-moment correlations between these task values and positive emotions did not remain sufficiently stable across situations, so that such dispositional tendencies could have shown up.

4.4. Theoretical implications

In this study we aimed to gain a more differentiated understanding of specific expectancy-value appraisals and achievement emotions by combining Eccles and Wigfield's SEVT and Pekrun's CVT. When integrating these two overlapping theories, some theoretical challenges arise regarding definitions, also called jingle (different constructs named similarly) and jangle fallacies (same constructs named differently; see Block, 1995). For example, there is a strong overlap between interest, a central component of intrinsic value, and enjoyment (Ainley, 2007; Ainley & Hidi, 2014). Eccles and Wigfield (2020) define intrinsic value (which they also call interest value) as the enjoyment an individual gets when doing a task, while Hidi & Renninger's (2006) interest value includes feelings of enjoyment and excitement, indicating that high intrinsic value inherently reflects enjoyment. In line with prior work by Gaspard, Dicke, Flunger, Schreier, et al. (2015), we therefore operationalized intrinsic value as "liking." Still, in our study it might be that the value (i.e., intrinsic value) that is supposed to determine the occurrence of a specific emotion (i.e., enjoyment) already reflects the corresponding emotion per se, suggesting a jangle fallacy.

Our study also showed that assessing negative task value, such as opportunity cost, is worthwhile because our results showed that cost was consistently related to negative emotions. Furthermore, it makes sense to consider negative task values in order to better identify specific task characteristics, for example, when designing individualized learning tasks for students. After all, the SEVT takes task value as a net value derived from both the benefits and costs of a specific task or activity into account (Eccles & Wigfield, 2020). Future studies could also consider effort costs (i.e., the extent of effort to complete a learning task and whether it is worthwhile; Eccles & Wigfield, 2020) and to what extent they relate to specific achievement emotions. However, the third facet, emotional costs (i.e., affective consequences of task engagement such as stress or anxiety; Eccles & Wigfield, 2020), seems to be less suitable for predicting emotions to avoid another jangle fallacy.

On the situation level, we found interaction effects of expectancy and costs on frustration and boredom. Such interactive associations can have important implications. Although students' negative consequences in engaging in a particular learning activity are supposed to be related to negative emotions, our findings suggest that students' ability-related expectancy did diminish these emotions, even if dealing with the learning situation was associated with high costs. This underlines the importance of giving students learning tasks in which they experience themselves to be competent, because this is not only emotionally favorable, but also might buffer the negative effects of high costs.

Finally, with the exception of cost value, our results showed a higher degree of within-person variability regarding expectancy-value appraisals and achievement emotions compared to between-person differences. This underlines Eccles and Wigfield's claims of SEVT that students' individual evaluation of their task facets varies along with their ability-expectation beliefs from one situation to another.

4.5. Limitations and future directions

To our knowledge, this study is among the first to examine momentary expectancies, values, and costs in specific learning situations, and to relate such momentary variables to students' achievement emotions. However, several important limitations, implications, and open questions require further attention.

First, we chose validated, but single-item measures to assess the relevant constructs in order to keep the state questionnaire brief. This could potentially be a threat to reliability and validity, but evidence suggests that single-item measures often have satisfactory psychometric properties and predictive validity (see Gogol et al., 2014), and have been routinely used for the assessment of students' emotional experiences (Bieg et al., 2013; Goetz et al., 2014; Lauermann et al., 2017).

Second, our study sample consisted of university students in a

blended-learning context. Thus, it is unclear whether these findings can be generalized to students learning in schools or other non- or full-digital learning formats as well as more active learning forms, such as group work. Systematic replications in diverse samples could examine whether different learning contexts elicit similar appraisal-emotion associations, or if not, which exact person and context characteristics determine such patterns of expectancies, values, and emotions. Furthermore, whether our findings might generalize across different cost components, other object foci (i.e., prospective achievement emotions) or other emotions (e.g., anxiety or hopelessness) remains an open empirical question and warrants further attention.

Third, although appraisal theories such as CVT focus on the causal role of appraisal dimensions, each emotion component also conversely affects appraisals (Scherer & Moors, 2019). The CVT also emphasizes explicitly the critical importance of feedback loops between emotions and control and value appraisals (Bieg et al., 2013) and the SEVT considers achievement emotions as concurrent correlates, predictors and outcomes of expectancies and values. In this study we focused on concurrent in-the-moment correlations between appraisals and emotions. Future studies should systematically examine the predictive role of appraisals and the dynamic situational interplay between appraisals and emotions. Furthermore, our study underscores the importance of emotion-specific hypotheses rather than hypothesizing about positively or negatively valenced emotion.

Finally, it is unclear if the value always moderates the link between expectancy and the corresponding emotion or vice versa. It also might be that the value directly evokes achievement emotions. Future experimental studies are necessary to gain further insight into the moderating role of these appraisals (see Bieg et al., 2013).

4.6. Conclusions

Our analyses corroborate key theoretical assumptions of CVT and SEVT that success expectancy and different task value facets corresponded with enjoyment, hope, frustration, and boredom. Furthermore, we observed a higher degree of within-person variability compared to between-person differences, corresponding to previous findings on the situational heterogeneity of students' motivation and emotion (e.g., Bieg et al., 2013; Dietrich et al., 2017; Dietrich et al., 2019; Kiuru et al., 2020). In this study we showed that using Eccles et al.'s refined conceptualization of several task value facets is useful to gain in-depth knowledge on the functioning of discrete achievement emotions. For example, although both attainment and utility value are considered as positive task value facets, students only experienced stronger positive emotions in learning situations of high utility value. Furthermore, our findings suggest that it is worthwhile to include negative value aspects, since the cost facet consistently related to frustration and boredom, and even interactively with expectancy. These findings indicate that different quality features of a learning task might be reflected in very specific emotional experiences. Our study is an important building block on the way to integrating these two expectancy-value models and contributes to recent developments towards a more unified approach of motivation theories (see Koenka, 2020).

Authors' contributions

The data collection was designed and conducted by Julia Dietrich.

Sebastian Born, Julia Dietrich, and Belinda Berweger designed and conducted the analyses for this study.

Belinda Berweger wrote the original draft.

Declaration of competing interest

We have no known conflict of interest to disclose.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.learninstruc.2021.101546.

References

Ahmed, W., van der Werf, G., Minnaert, A., & Kuyper, H. (2010). Students' daily emotions in the classroom: Intra-individual variability and appraisal correlates. *British Journal of Educational Psychology, 80*(4), 583–597. https://doi.org/10.1348/000709910X498544

Ainley, M. (2007). Being and feeling interested: Transient state, mood, and disposition. In P. A. Schutz, & R. Pekrun (Eds.), *Emotion in education* (pp. 147–163). Elsevier. https://doi.org/10.1016/B978-012372545-5/50010-1.

Ainley, M., & Hidi, S. (2014). Interest and enjoyment. In R. Pekrun, & L. Linnenbrink-Garcia (Eds.), *Educational psychology handbook series. International handbook of emotions in education* (pp. 205–227). Routledge Taylor & Francis Group.

Artino, A. R., & Jones, K. D. (2012). Exploring the complex relations between achievement emotions and self-regulated learning behaviors in online learning. *The Internet and Higher Education, 15*(3), 170–175. https://doi.org/10.1016/j.iheduc.2012.01.006

Barron, K. E., & Hulleman, C. S. (2015). Expectancy-value-cost model of motivation. *Psychology, 84*, 261–271. https://doi.org/10.1016/B978-0-08-097086-8.26099-6

Bieg, M., Goetz, T., & Hubbard, K. (2013). Can I master it and does it matter? An intraindividual analysis on control–value antecedents of trait and state academic emotions. *Learning and Individual Differences, 28*, 102–108. https://doi.org/10.1016/j.lindif.2013.09.006

Block, J. (1995). A contrarian view of the five-factor approach to personality description. *Psychological Bulletin, 117*(2), 187. https://doi.org/10.1037/0033-2909.117.2.187

Camacho-Morles, J., Slemp, G. R., Oades, L. G., Pekrun, R., & Morrish, L. (2019). Relative incidence and origins of achievement emotions in computer-based collaborative problem-solving: A control-value approach. *Computers in Human Behavior, 98*, 41–49. https://doi.org/10.1016/j.chb.2019.03.035

Chiang, E. S., Byrd, S. P., & Molin, A. J. (2011). Children's perceived cost for exercise: Application of an expectancy-value paradigm. *Health Education & Behavior, 38*(2), 143–149. https://doi.org/10.1177/1090198110376350

Cole, J. S., Bergin, D. A., & Whittaker, T. A. (2008). Predicting student achievement for low stakes tests with effort and task value. *Contemporary Educational Psychology, 33*(4), 609–624. https://doi.org/10.1016/j.cedpsych.2007.10.002

Daniels, L. M., & Stupnisky, R. H. (2012). Not that different in theory: Discussing the control-value theory of emotions in online learning environments. *The Internet and Higher Education, 15*(3), 222–226. https://doi.org/10.1016/j.iheduc.2012.04.002

Depaoli, S., & van de Schoot, R. (2017). Improving transparency and replication in Bayesian statistics: The WAMBS-Checklist. *Psychological Methods, 22*(2), 240. https://doi.org/10.1037/met0000065

Dietrich, J., Greiner, F., Weber-Liel, D., Berweger, B., Kämpfe, N., & Kracke, B. (2021). Does an individualized learning design improve university student online learning? A randomized field experiment. *Computers in Human Behavior, 122*, 106819. https://doi.org/10.1016/j.chb.2021.106819

Dietrich, J., Moeller, J., Guo, J., Viljaranta, J., & Kracke, B. (2019). In-the-moment profiles of expectancies, task values, and costs. *Frontiers in Psychology, 10*, 1662. https://doi.org/10.3389/fpsyg.2019.01662

Dietrich, J., Viljaranta, J., Moeller, J., & Kracke, B. (2017). Situational expectancies and task values: Associations with students' effort. *Learning and Instruction, 47*, 53–64. https://doi.org/10.1016/j.learninstruc.2016.10.009

Durik, A. M., Vida, M., & Eccles, J. S. (2006). Task values and ability beliefs as predictors of high school literacy choices: A developmental analysis. *Journal of Educational Psychology, 98*(2), 382. https://doi.org/10.1037/0022-0663.98.2.382

Eccles, J. S., & Wigfield, A. (2020). From expectancy-value theory to situated expectancy-value theory: A developmental, social cognitive, and sociocultural perspective on motivation. *Contemporary Educational Psychology, 61*, 101859. https://doi.org/10.1016/j.cedpsych.2020.101859

Enders, C. K., & Tofighi, D. (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. *Psychological Methods, 12*(2), 121. https://doi.org/10.1037/1082-989X.12.2.121

Frenzel, A. C., Pekrun, R., & Goetz, T. (2007). Girls and mathematics—a "hopeless" issue? A control-value approach to gender differences in emotions towards mathematics. *European Journal of Psychology of Education, 22*(4), 497. https://doi.org/10.1007/BF03173468

Gaspard, H., Dicke, A.-L., Flunger, B., Brisson, B. M., Häfner, I., Nagengast, B., & Trautwein, U. (2015). Fostering adolescents' value beliefs for mathematics with a relevance intervention in the classroom. *Developmental Psychology, 51*(9), 1226–1240. https://doi.org/10.1037/dev0000028

Gaspard, H., Dicke, A.-L., Flunger, B., Schreier, B., Häfner, I., Trautwein, U., & Nagengast, B. (2015). More value through greater differentiation: Gender differences in value beliefs about math. *Journal of Educational Psychology, 107*(3), 1226–1240. https://doi.org/10.1037/edu0000003

Gelman, A., Carlin, J. B., Stern, H. S., & Rubin, D. B. (2004). *Bayesian data analysis*. Chapman & Hall. https://doi.org/10.1201/9780429258411. CRC Texts in Statistical Science.

Goetz, T., Frenzel, A. C., Hall, N. C., Nett, U. E., Pekrun, R., & Lipnevich, A. A. (2014). Types of boredom: An experience sampling approach. *Motivation and Emotion, 38*(3), 401–419. https://doi.org/10.1007/s11031-013-9385-y

Goetz, T., Frenzel, A. C., Stoeger, H., & Hall, N. C. (2010). Antecedents of everyday positive emotions: An experience sampling analysis. *Motivation and Emotion, 34*(1), 49–62. https://doi.org/10.1007/s11031-009-9152-2

Gogol, K., Brunner, M., Goetz, T., Martin, R., Ugen, S., Keller, U., Fischbach, A., & Preckel, F. (2014). "My questionnaire is too long!" the assessments of motivational-affective constructs with three-item and single-item measures. *Contemporary Educational Psychology, 39*(3), 188–205. https://doi.org/10.1016/j.cedpsych.2014.04.002

Guo, J., Nagengast, B., Marsh, H. W., Kelava, A., Gaspard, H., Brandt, H., Cambria, J., Flunger, B., Dicke, A.-L., & Häfner, I. (2016). Probing the unique contributions of self-concept, task values, and their interactions using multiple value facets and multiple academic outcomes. *AERA Open, 2*(1), Article 2332858415626884. https://doi.org/10.1177/2332858415626884

Hall, N. C., Sampasivam, L., Muis, K. R., & Ranellucci, J. (2016). Achievement goals and emotions: The mediational roles of perceived progress, control, and value. *British Journal of Educational Psychology, 86*(2), 313–330. https://doi.org/10.1111/bjep.12108

Harackiewicz, J. M., Tibbetts, Y., Canning, E., & Hyde, J. S. (2014). Harnessing values to promote motivation in education. *Advances in Motivation and Achievement: A Research Annual, 18*, 71. https://doi.org/10.1108/S0749-742320140000018002

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist, 41*(2), 111–127. https://doi.org/10.1207/s15326985ep4102_4

Hox, J., van de Schoot, R., & Matthijsse, S. (2012). How few countries will do? Comparative survey analysis from a Bayesian perspective. *Survey Research Methods, 2*(6). https://doi.org/10.18148/srm/2012.v6i2.5033

Kiuru, N., Spinath, B., Clem, A.-L., Eklund, K., Ahonen, T., & Hirvonen, R. (2020). The dynamics of motivation, emotion, and task performance in simulated achievement situations. *Learning and Individual Differences, 80*, 101873. https://doi.org/10.1016/j.lindif.2020.101873

Koenka, A. C. (2020). Academic motivation theories revisited: An interactive dialog between motivation scholars on recent contributions, underexplored issues, and future directions. *Contemporary Educational Psychology*, 101831. https://doi.org/10.1016/j.cedpsych.2019.101831

Kögler, K., & Göllner, R. (2018). Control-value appraisals predicting students' boredom in accounting classes: A continuous-state-sampling approach. *Empirical Research in Vocational Education and Training, 10*(1), 4. https://doi.org/10.1186/s40461-018-0065-8

Lauermann, F., Eccles, J. S., & Pekrun, R. (2017). Why do children worry about their academic achievement? An expectancy-value perspective on elementary students' worries about their mathematics and reading performance. *ZDM, 49*(3), 339–354. https://doi.org/10.1007/s11858-017-0832-1

Marsh, H. W., Lüdtke, O., Robitzsch, A., Trautwein, U., Asparouhov, T., Muthen, B., et al. (2009). *Multivariate Behavioral Research, 44*, 764–802. https://doi.org/10.1080/00273170903333665

Morin, A. J. S., Marsh, H. W., Nagengast, B., & Scalas, L. F. (2014). Doubly latent multilevel analyses of classroom climate: An illustration. *The Journal of Experimental Education, 82*(2), 143–167. https://doi.org/10.1080/00220973.2013.769412

Muthén, B. O., Muthén, L. K., & Asparouhov, T. (2010). *Bayesian analysis using Mplus. MPlus technical report)*. Retrieved from www. statmodel. com.

Muthén, L. K., & Muthén, B. O. (1998-2017). *Mplus User's Guide. Eighth Edition.*. Los Angeles, CA: Muthén & Muthén.

Nagengast, B., Marsh, H. W., Scalas, L. F., Xu, M. K., Hau, K.-T., & Trautwein, U. (2011). Who took the "×" out of expectancy-value theory? A psychological mystery, a substantive-methodological synergy, and a cross-national generalization. *Psychological Science, 22*(8), 1058–1066. https://doi.org/10.1177/0956797611415540

Pekrun, R. (2006). The Control-Value Theory of Achievement Emotions: Assumptions, corollaries, and implications for educational research and practice. *Educational Psychology Review, 18*(4), 315–341. https://doi.org/10.1007/s10648-006-9029-9

Pekrun, R. (2018). Control-value theory: A social-cognitive approach to achievement emotions. In G. A. D. Liem, & D. M. McInerney (Eds.), *Big theories revisited 2* (pp. 165–190). IAP.

Pekrun, R., Goetz, T., Daniels, L. M., Stupnisky, R. H., & Perry, R. P. (2010). Boredom in achievement settings: Exploring control–value antecedents and performance outcomes of a neglected emotion. *Journal of Educational Psychology, 102*(3), 531–549. https://doi.org/10.1037/a0019243

Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Academic emotions in students' self-regulated learning and achievement: A program of qualitative and quantitative research. *Educational Psychologist, 37*(2), 91–105. https://doi.org/10.1207/S15326985EP3702_4

Educational psychology handbook series. In Pekrun, R., & Linnenbrink-Garcia, L. (Eds.), *International handbook of emotions in education*, (2014). Routledge Taylor & Francis Group. https://doi.org/10.4324/9780203148211.

Pekrun, R., & Perry, R. P. (2014). Control-value theory of achievement emotions. In R. Pekrun, & L. Linnenbrink-Garcia (Eds.), *Educational psychology handbook series. International handbook of emotions in education*. Routledge Taylor & Francis Group. https://doi.org/10.4324/9780203148211.

Putwain, D. W., Pekrun, R., Nicholson, L. J., Symes, W., Becker, S., & Marsh, H. W. (2018). Control-value appraisals, enjoyment, and boredom in mathematics: A longitudinal latent interaction analysis. *American Educational Research Journal, 55*(6), 1339–1368. https://doi.org/10.3102/0002831218786689

Reitzle, M., & Dietrich, J. (2019). From between-person statistics to within-person dynamics. *Diskurs Kindheits-Und Jugendforschung/Discourse. Journal of Childhood and Adolescence Research, 14*(3), 323–342. https://doi.org/10.3224/diskurs.v14i3.06

Scherer, K. R., & Moors, A. (2019). The emotion process: Event appraisal and component differentiation. *Annual Review of Psychology, 70*, 719–745. https://doi.org/10.1146/annurev-psych-122216-011854

Tymms, P. (2004). Effect sizes in multilevel models. In I. Schagen, & K. Elliot (Eds.), *But what does it mean? The use of effect sizes in educational research* (pp. 55–66). London, UK: National Foundation for Educational Research.

van de Schoot, R., Broere, J. J., Perryck, K. H., Zondervan-Zwijnenburg, M., & van Loey, N. E. (2015). Analyzing small data sets using Bayesian estimation: The case of posttraumatic stress symptoms following mechanical ventilation in burn survivors. *European Journal of Psychotraumatology, 6*(1), 25216. https://doi.org/10.3402/ejpt.v6.25216

Watkinson, E. J., Dwyer, S. A., & Nielsen, A. B. (2005). Children theorize about reasons for recess engagement: Does expectancy-value theory apply? *Adapted Physical Activity Quarterly, 22*(2), 179–197. https://doi.org/10.1123/apaq.22.2.179

Wigfield, A., Eccles, J. S., Fredricks, J. A., Simpkins, S., Roeser, R. W., & Schiefele, U. (2015). Development of achievement motivation and engagement. In R. M. Lerner (Ed.), *Handbook of child psychology and developmental science* (pp. 1–44). John Wiley & Sons, Inc. https://doi.org/10.1002/9781118963418.childpsy316.

Zitzmann, S., Helm, C., & Hecht, M. (2021). Prior specification for more stable Bayesian estimation of multilevel latent variable models in small samples: A comparative investigation of two different approaches. *Frontiers in Psychology, 11*, 4027. https://doi.org/10.3389/fpsyg.2020.611267