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Student adaptability, emotions, and achievement: Navigating new academic terrains in a global crisis☆

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1. Introduction

1.1. Impact of COVID-19 on higher education students

The COVID-19 pandemic drastically changed the higher education landscape across the globe. In spring 2020, students abruptly shifted from familiar face-to-face instruction to new and improvised distance learning formats. Schools and universities were forced to resort to emergency remote teaching, leaving instructors and students alike with little time to transition (Hofer et al., 2021; Schleicher, 2020). Although many higher education institutions were quick to manage this transition, and online courses were increasingly offered prior to COVID-19, relying solely on digital learning remains a novel and uncertain circumstance—especially in light of the pandemic (Schleicher, 2020). In the United States, for example, a mere 13% of higher education students were exclusively enrolled in distance courses prior to COVID-19 (NCES, 2019). In Germany, the context of the present research, digitalization in higher education has—despite being increasingly discussed by practitioners and policy makers (German Forum for Higher Education in the Digital Age, 2016)—been rather slow and difficult to implement. Additional evidence shows that the use of digital tools in higher education in Germany as well as other countries is largely limited to basic tasks such as accessing course materials, and that students often feel ill-prepared to use digital courseware effectively (Bond et al., 2018). The spring 2020 semester thus posed a novel challenge for higher education students.

Initial evidence indicates that the COVID-19-induced disruption to routine instruction has indeed impacted students' mental health and learning. International surveys reveal increased (self-reported) levels of anxiety, frustration, and hopelessness, as well as worries about future studies, increased workloads, academic performance, and even professional careers among higher education students (Aristovnik et al., 2020; Chandra, 2020; Son et al., 2020). Similarly, Austrian university students reported reduced motivation due to uncertainty about their current and future studying at the start of the spring 2020 semester, and about 30% of surveyed students reported that their well-being had dropped since the beginning of the semester during a mid-semester assessment (Schober et al., 2020). Furthermore, research on German university students' COVID-19-related academic experiences suggests that they adjusted differentially well to these unprecedented changes, with lower levels of digital readiness and digital learning experience being linked with higher levels of stress and lower levels of study-related joy (Händel,

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Stephan, et al., 2020). Recent findings from Canada reveal that individual differences in students' achievement goals were closely linked to course-related engagement and perceived academic success during emergency remote teaching in spring 2020 (Daniels et al., 2021). As such, interindividual differences in students' academic adjustment, and lack of adjustment in particular, can have severe consequences for societies and economies across the globe, as suggested by a recent report on the economic impact of 'educational losses' by Hanushek and Woessmann (2020).

In our study, we aimed to better understand how higher education students are handling the academic ramifications of the pandemic, and which students may particularly need emotional support. Specifically, we examined whether individual differences in students' capacity to cognitively, affectively, and behaviorally adjust to situational uncertainty and novelty (i.e., adaptability; Martin et al., 2013), as implied by the sudden shift to digital learning, could help explain differences in their course-related emotional experiences (joy, hope, anxiety, hopelessness). Furthermore, we examined relations between adaptability and learning outcomes in a digital university course above and beyond their prior experience with digital courseware. While the present study was conducted within the context of the COVID-19 pandemic, its findings are relevant from a broader perspective in terms of shedding light on factors that drive students' emotional well-being and learning in times of change and uncertainty.

1.2. Definition and importance of (student) adaptability in educational settings

Adaptability is defined as an individual's capacity to make "appropriate cognitive, behavioral, and/or affective adjustments in the face of uncertainty and novelty" (Martin et al., 2013). Martin et al. (2013) contend that this trait-like capacity constitutes a special case of (general) self-regulation of cognition, behavior, and affect that comes into play when individuals face uncertainty and novelty that disrupts their routines and imposes new circumstances, which was the case during the first 'global lockdown' in spring 2020. From this perspective, it can be assumed that individual differences in adaptability, which is typically conceptualized as a context-unspecific disposition pertaining to how individuals handle uncertainty and change (VandenBos, 2015), are germane to the COVID-19 higher education context (Besser et al., 2020).

Past research indeed indicates that adaptability plays an important role in educational settings, and predicts a host of academic and non-academic student outcomes. These include higher class participation and more positive behavioral conduct in school, higher academic engagement, lower academic self-handicapping, higher academic achievement, university students' degree completion, and higher general satisfaction with life (Burns et al., 2018; Collie et al., 2017; Collie & Martin, 2017; Holliman et al., 2018; Martin et al., 2013; Putwain et al., 2020). Notably, adaptability has been found to predict these outcomes even after controlling for socio-demographic factors and prior variance in the target variables, and above and beyond related constructs pertaining to individuals' capacity to cope with (academic) adversity and setbacks, including resilience, coping, and academic buoyancy, as well as students' self-regulation of learning behaviors (Martin, 2017b; Martin et al., 2013). Moreover, Martin et al. (2013) found that adaptability and self-regulation are separable constructs that also show differential relations with academic and non-academic student outcomes.

In essence, adaptability may be beneficial for coping with situational adversity (e.g., failing a test) and may thus be related to constructs like self-regulation, resilience, or buoyancy, but is conceptually and empirically distinct from these constructs in terms of pertaining to situational uncertainty/novelty and change. Taken together, evidence indicating that adaptability is critically important for students' academic success and personal well-being is accumulating.

1.3. Student adaptability and achievement emotions

Initial evidence further suggests that adaptability can shape students' academic emotional experiences. Martin et al. (2013) found high school students' adaptability to positively predict changes in their enjoyment of school over the course of one year. Turning to the context of COVID-19, Besser et al. (2020) recently employed a modified, context-specific measure assessing Israeli university students' adaptability in responding to the pandemic to examine how individual differences in adaptability to the digital transformation related to their current learning experiences. While their cross-sectional findings are not causally interpretable, the data indicates that students' adaptability is associated with increased positive and decreased negative moods concerning their learning experiences during this crisis. Similarly, Zhang et al. (2021) found Chinese university students' adaptability to be positively and negatively related to positive and negative academic affect, respectively. By focusing on global positive versus negative affect, however, Besser et al. (2020) and Zhang et al. (2021) do not provide insights into relations between adaptability and different types of emotions students may be experiencing in relation to their learning, although prior research suggests that students' emotions are best conceptualized as discrete emotions, and highlights the importance of differentiating between these emotions given their differential functions for motivation, learning behaviors, and achievement outcomes (Pekrun et al., 2011).

Furthermore, student adaptability has been found to indirectly predict lower levels of anxiety about academic performance via increased perceptions of personal control over academic performance and schoolwork in high school students (Martin et al., 2015). This suggests that adaptability may predict different achievement emotions, that is, emotions tied to experiences of success or failure during achievement activities such as attending class, studying, or taking tests (Pekrun, 2018). According to the control-value theory of achievement emotions (CVT; Pekrun, 2006, 2018), these emotions are substantially determined by individuals' perceptions of personal control over, and value of, academic tasks and demands. CVT suggests that these perceptions can be shaped not only by characteristics of students' learning environments, but also by individual differences pertaining to general temperament, student gender, or achievement goals, for instance. Building upon this framework, we posited individual differences in students' adaptability to be systematically linked to different achievement-related emotions, based on the assumption that adaptability likely impacted their perceived control over their learning and achievement in the COVID-19 context and its inherent uncertainties (i.e., their perceived capacity to handle these circumstances adaptively), and thus, their expectancies for successfully mastering course demands in a new and unfamiliar digital format. As noted, initial evidence suggests that adaptability can enhance students' perceived academic control (Martin et al., 2015; see also Putwain et al., 2020, for a discussion).

Given the nature of the adaptability construct and its linkages with uncertainty and novelty, we chose to examine its linkages with prospective emotions posited to be linked to individuals' subjective (un-) certainty of future success and failure in CVT (Pekrun, 2018; see also Miceli & Castelfranchi, 2005), namely hope, anxiety, and hopelessness. As the COVID-19 higher education context constitutes a low control setting, higher versus lower adaptability may be a particularly important trait predisposing individuals towards higher or lower perceptions of control, that is, towards higher or lower certainty about their in-/capacities to meet academic demands, respectively. In keeping with CVT, perceived control pertaining to attainable achievement outcomes has been found to promote positive emotions such as hope, and to reduce negative emotions, such as anxiety and hopelessness (Goetz et al., 2010; Mercan, 2020; Shao et al., 2020; see Pekrun & Perry, 2014, for a review). This research also shows that students' enjoyment of learning is positively related to their perceptions of control and certainty about future success. Moreover, prior research has shown that adaptability is systematically linked to high school students' school-related

enjoyment (Martin et al., 2013). As such, we also included this emotion in our study to probe replicability in an undergraduate sample of learners. Taken together, we expected students' adaptability to be positively related to their course-related joy and hope, and negatively related to their anxiety and hopelessness (cf. H1; see Section 2 for an overview of our hypotheses).

Furthermore, although speculative, it is likely that adaptability shapes students' perceptions of value of course-related activities. Specifically, students with low adaptability may view learning situations involving uncertainty and novelty as threatening and aversive, which may lead to negative valuation of the course. Conversely, high adaptability may dampen this negative valuation, or promote more positive valuation of the current situation as a challenge to be mastered. As suggested by CVT, value perceptions are also important antecedents of achievement emotions, with positive valuation boosting positive, and negative valuation boosting negative emotions. These patterns align with the assumption that adaptability should promote positive and reduce negative achievement emotions related to possible success or failure.

Research examining relations between adaptability and discrete achievement emotions is still scarce, particularly in higher education. We thus expanded upon prior research on adaptability and emotions by considering not only joy and anxiety, but also hope and hopelessness experienced by students attending a university course who were abruptly forced to shift to digital learning due to the COVID-19 pandemic, and examined how individual differences in their adaptability relate to these affective experiences. In particular, COVID-19 can be seen as a natural paradigm that accentuates interindividual differences in how students experience the novel and unprecedented shift to global online teaching (see Daumiller, Rinas et al., 2021, for similar argumentation). This provides ideal grounds to study the effect of adaptability for dealing with this change to digital teaching.

1.4. Achievement emotions and learning outcomes

In addition to influencing students' well-being and life satisfaction, CVT posits that achievement emotions impact cognitive (e.g., memory processes), behavioral (e.g., use of learning strategies), and motivational processes (e.g., effort investment) that are relevant to learning and learning outcomes (Goetz & Hall, 2013; Pekrun, 2018; Zeidner, 2014). More specifically, CVT proposes that positive activating emotions such as joy and hope are posited to benefit academic performance, for instance, by enhancing engagement with learning material and promoting the use of effective learning strategies. Negative deactivating emotions such as hopelessness, in contrast, should lead to reduced effort investment, motivation, and thus performance. Performance effects of negative activating emotions such as anxiety can be more variable, as such, emotions can boost extrinsic motivation to avoid failure in some individuals, but associated worry cognitions may impair the encoding as well as recall of information in test situations. However, the modal impact of anxiety on learning outcomes is posited to be negative (Goetz & Hall, 2013), implying that for most individuals and under most conditions, anxiety should be detrimental to learning and performance. Consequently, we posited students' joy and hope to be positively, and their anxiety and hopelessness to be negatively related to their learning outcomes (cf. H2).

Cumulative findings indicate that tertiary-level students' achievement emotions are significantly related to their learning outcomes (Camacho-Morles et al., 2021; Loderer et al., 2020; Pekrun et al., 2011; Richardson et al., 2012; Shao et al., 2020) and provide evidence for the aforementioned patterns of correlations. As such, emotions constitute important drivers rather than mere by-products of students' learning, rendering a deeper understanding of their antecedents—including those pertaining to individual differences between students—which are fundamentally important for practitioners and policy-makers seeking to foster student learning and well-being, especially when conditions for learning are particularly strenuous.

1.5. Direct and indirect effects of adaptability on learning outcomes

Several studies suggest that adaptability may directly and positively predict learning outcomes (Martin et al., 2012; Martin et al., 2015). In line with this, we also expected to find direct links (cf. H3). However, recent research focusing on tertiary-level learners has failed to find such direct effects (e.g., Collie et al., 2017). Evidence regarding direct linkages is thus somewhat inconsistent, and more research examining these effects is needed.

Evidence also points to indirect associations between adaptability and student outcomes. Of particular interest to the present research, Zhang et al. (2021) showed that undergraduates' learning-related affect mediates linkages between adaptability and self-reported engagement, resulting in positive mediation for positive affect and negative mediation for negative affect (see also Collie et al., 2017, for mediational evidence linking adaptability with undergraduates' end-of-semester grades via reduced educational disengagement). While evidence for the interplay between adaptability, discrete achievement emotions, and objective indicators of learning is still lacking, we followed Zhang et al.'s (2021) reasoning and posited achievement emotions to mediate relations between adaptability and learning outcomes (cf. H4).

2. Summary of study aims and hypotheses

Given the importance of achievement emotions for students' learning, examining which factors contribute to students' arousal within particularly novel and challenging academic settings, such as those brought forth by the current pandemic, is pivotal for understanding which students may be particularly in need of emotional support. We examined whether student differences in their adaptability contribute to explaining variation in course-related achievement emotions (joy, hope, anxiety, hopelessness) and learning outcomes (subjective/perceived learning gains and knowledge test scores). As students' prior experiences with digital learning have also been found to relate to their socio-emotional experiences at university in recent COVID-19-related research (Händel, Bedenlier, et al., 2020), we controlled for potential differences in prior experience when examining adaptability-emotion-achievement linkages.

Expanding upon prior research on adaptability, emotions, and learning outcomes that we outlined above, we tested the following main hypotheses:

Hypothesis 1 (H1). : Students' adaptability is positively related to their course-related joy and hope, and negatively related to their anxiety and hopelessness.

Hypothesis 2 (H2). : Students' joy and hope are positively, and anxiety and hopelessness are negatively related to their perceived learning gains and knowledge test scores.

Hypothesis 3 (H3). : Students' adaptability is positively related to their perceived learning and knowledge test scores.

Hypothesis 4 (H4). : Students' emotions mediate the relations between adaptability and learning outcomes.

As detailed in the next section, we used a prospective-longitudinal design involving three assessments at the beginning (T1), middle (T2), and end (T3) of the spring 2020 semester to provide a clear temporal ordering of our focal variables and test the proposed relations.

3. Method

3.1. Sample

Participants were recruited via email from an ‘introduction to

psychology' course mandatory for students in different pre-service teaching programs (i.e., programs focused on teaching at elementary or different secondary school forms) and studying different subjects (e.g., mathematics, natural sciences, language arts, foreign languages, history, geography, arts, physical education). Participants attended a South-German university which offered the aforementioned course in a digital format due to the lockdown in March 2020 (with the course itself starting mid-April). This educational institution constitutes a traditional university within which face-to-face teaching formats constitute regular practice. Eighty-nine undergraduates ($M_{age} = 20.79$ years, $SD = 3.60$, 54 female; 12% enrolled in their first semester and year at university, 43% enrolled in their third semester) agreed to participate. The digital course involved weekly synchronous online sessions introducing various psychological concepts and theories, interactive tasks designed to illustrate practical implications thereof to the context of teaching and learning, group-based discussions, as well as (asynchronous) weekly completion of worksheets graded on a pass/fail basis and required for course completion. As part of the first assessment (T1; see Section 3.2), students indicated how prepared they generally felt for digital learning (1 = *very poorly*, 5 = *very well*). Over one-third of participants indicated feeling ill-prepared or very ill-prepared (31.4%), and close to half of the remaining participants reported feeling only moderately prepared (43.8%; $M = 2.79$, $SD = 0.91$), with the remaining students reporting higher levels of preparedness. These findings imply that students in the present sample were, in large parts, confronted with novel/unfamiliar learning formats, and felt differentially well prepared for handling these circumstances. This may be little surprising considering that German higher education institutions in general still predominantly draw on traditional face-to-face teaching (Bond et al., 2018).

3.2. Procedure

The study involved three assessments at the beginning (T1), middle (T2), and end (T3) of the spring 2020 semester (all timepoints took place during the lockdown). We employed a prospective longitudinal design in which we measured adaptability and prior experience with digital learning at T1, achievement emotions at T2, and performance outcomes at T3. Measures were administered via an online platform, with the exception of the T3 knowledge test hosted on campus. To ensure anonymity, data from each timepoint were linked using randomly generated participant codes. Students provided informed consent prior to their participation, were told they could withdraw from the study at any time, and received information about the general study aims. Students received course credit for their voluntary study participation. This research was conducted in accordance with the German and the American Psychological Association ethical principles regarding research involving human participants and the institutional requirements at the respective university.[1]

3.3. Materials and measures

Table 1 provides sample items, reliabilities, and descriptive statistics for study measures. To examine the internal validity of the self-report measures used, we ran a CFA using weighted least squares (WLSMV) estimation to examine whether items were loading on the intended latent factors (i.e., adaptability, prior experience with digital learning, joy, hope, anxiety, hopelessness, and perceived learning gains). Overall, the CFA fit the data well, ($\chi^2(1304) = 1530.16$, $p < .000$; CFI = 0.969; TLI = 0.967; RMSEA = 0.044; SRMR = 0.094), attesting to the structural validity of our measures (cf. Hu & Bentler, 1999; see Section 3.4 on model fit interpretation).

3.3.1. Adaptability and prior experience with digital learning

Adaptability was measured using a German version of Martin et al.'s (2012) instrument rated on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*). To ensure content validity of the scale, we used a back-to-back translation procedure involving native speakers in its development. This scale contains six items addressing cognitive-behavioral adaptability, and three items addressing affective adaptability. Previous research documents adequate reliability and validity of the scale when both factors are combined into one adaptability factor (Collie et al., 2017; Martin et al., 2013; Martin et al., 2015; Putwain et al., 2020). Moreover, Martin et al. (2012) explicitly suggest to combine the cognitive-behavioral and affective factors into a single global indicator to avoid collinearity issues due to their strong interrelatedness, especially when using adaptability as a predictor. In the present research, we followed this recommendation, also justified by good internal consistency, $\omega = 0.83$.

Further, students reported their prior experience with different digital courseware used in the course (e.g., learning management system; video conference system) on a scale from 1 (*none*) to 5 (*a lot*).

3.3.2. Achievement emotions

Students' course-related joy (six items), hope (four items), anxiety (twelve items), and hopelessness (nine items) were measured on a scale from 1 (*does not apply at all*) to 5 (*applies completely*). Items were taken from the Achievement Emotions Questionnaire which has proven reliable and valid with undergraduate samples (Pekrun et al., 2011) and directly referred to students' experiences before, during, and after the digital course. Herein, we accounted for the fact that emotions are typically organized in domain−/course-specific ways (Goetz et al., 2007; Pekrun, 2018).

3.3.3. Test scores and perceived learning

Students completed a knowledge test consisting of 20 multiple-choice questions on the material covered in the lecture and tutorial course. Questions varied in terms of levels of difficulty, covered different educational objectives (e.g., recalling, understanding, and applying information), and were piloted with students not enrolled in the course. We obtained permission to retrieve final test scores from 66 students who completed the test.[2] Students' subjective evaluation of their learning was assessed prior to the knowledge test using a German translation of a subscale (5 items) of the SEEQ (Student Evaluation of Educational Quality; Marsh, 1982; see Daumiller, Grassinger, et al, 2021, for evidence on excellent scale reliabilities and validity of the German SEEQ in university samples) based on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*).

3.4. Data analysis and missing data

To test our hypotheses, we estimated a structural equation model (SEM) using maximum likelihood estimation with robust standard errors (MLR) in Mplus 8.1 (Muthén & Muthén, 2017). Adaptability was modeled as a predictor for each of the four achievement emotions, which were in turn modeled as predictors for perceived learning and knowledge test scores, controlling for prior experience with digital

[1] At the time of data collection, it was neither customary at the respective university, nor at many other German universities, to seek ethics approval for survey studies on subjective experiences. The study exclusively made use of anonymous questionnaires. We had no reasons to assume that our survey would induce any negative states in the participants.

[2] Not all students in this study also participated in the knowledge test; students have the option of taking the test at a later point in their studies to give them more flexibility. Participation was similar to that in prior semesters. Correlational analyses showed that test attendance was not significantly related to adaptability, emotions, or perceived learning. Of note, there were no significant correlations between students' adaptability, emotions, and test attendance.

Table 1
Sample items and descriptive statistics for study measures.

Variable	Possible range	Sample item/description	*M*	*SD*	1.	2.	3.	4.	5.	6.	7.	8.
1. Prior experience with digital courseware	1–5	How much experience do you have with the following digital tools? – University learning management system	2.45	0.61	*0.65*[a]							
2. Adaptability	1–7	I am able to seek out new information, helpful people, or useful resources to effectively deal with new situations.	4.83	0.83	0.16	*0.82*						
3. Joy	1–5	The tasks to be completed in this digital course are fun.	2.57	0.77	−0.05	0.15	*0.84*					
4. Hope	1–5	I am hopeful that I can succeed in this course.	3.80	0.77	0.18	0.40***	0.32**	*0.89*				
5. Anxiety	1–5	I worry about failing.	2.61	1.15	−0.02	−0.51***	−0.15	−0.29**	*0.96*			
6. Hopelessness	1–5	I have given up all hope to understand the material.	1.49	0.75	−0.07	−0.47***	−0.21	−0.50***	0.71***	*0.95*		
7. Perceived learning gains	1–5	I have learned and understood the subject materials of this course.	3.81	0.72	0.22	0.06	0.29**	0.23*	0.05	−0.17	*0.84*	
8. Knowledge test scores	0–80	Multiple choice questions targeting content covered in "introduction to psychology" lecture	66.30	10.10	−0.02	−0.02	0.18	0.18	−0.16	−0.10	−0.23[b]	*0.80*

Note. Internal consistency (α) displayed in diagonal (italicized).
[a] Prior experience covered different types of digital courseware used in the present online course (see Method section).
[b] Students' perceived learning solely targeted the compulsory seminar accompanying the lecture within the introduction to psychology module.
* $p < .05$.
** $p < .01$.
*** $p < .001$ (two-sided).

courseware. Correlations between the emotions were allowed. In addition, we tested for mediation effects of adaptability on perceived learning and knowledge test scores via achievement emotions. Adaptability, emotions, perceived learning, and prior experience with digital courseware were modeled using the item-to-construct parceling approach to create two parcels per construct and reduce the amount of error in complex model estimation in which relations among latent constructs are of focal interest (Little et al., 2013).

As our hypotheses were directed, one-sided testing was used. Model fit was gauged using Hu and Bentler's (1999) guidelines suggesting that CFI and TLI values ≥ 0.95, and RMSEA and SRMR values ≤ 0.08 can be interpreted as indicating good fit (with RMSEA and SRMR ≤ 0.10 indicating acceptable fit). These values, however, may be overly strict for naturalistic data and should not be used as strict cut-off criteria (Heene et al., 2011). To interpret the magnitude of effects, we relied on empirically derived guidelines provided by Gignac and Szodorai (2016).[3] Furthermore, we conducted a post-hoc power analysis based on Monte Carlo simulation analyses (based on 50,000 repetitions) assuming medium effects for the multivariate statistical analyses described above. The results revealed a sufficient power of >0.82 to detect the presumed linkages tested in our analyses.

Attrition rates and amounts of missing data across all three measurement timepoints were low. Item-level percentages of missing data were as follows: 3% for adaptability, 3% for prior experience with digital courseware, 7% for achievement emotions, 24% for knowledge test scores, and 7% for perceived learning. Missing data for knowledge test scores was due to the fact that not all students took the test at the end of the term (see footnote 2).

[3] Gignac and Szodorai (2016) examined distributions of effect sizes using meta-analytically determined correlations reported in personality psychology literature. Based on their review, they propose to use the following benchmarks for interpreting the magnitude of small, moderate, and large effects, respectively: $r = 0.10$, 0.20, and.30. In contrast to the commonly used benchmarks proposed by Cohen (1988), these guidelines are empirically grounded and present a more tailored aid for interpreting the observed effects.

4. Results

4.1. Descriptive statistics

Descriptive statistics including zero correlations for all variables are reported in Table 1. Students' prior experience with digital courseware was below the scale midpoint of 3 representing 'moderate experience', with 76.7% of students achieving mean-levels of prior experience (across all tools listed) below 3. These data indicate that students had limited experience with digital educational technology.

In comparison to joy, anxiety, and hope, students in the current sample were found to have rather low levels of hopelessness. Prior experience with digital courseware was not substantially related to students' emotions or learning outcomes. Adaptability was positively related to students' subsequent course-related hope, and negatively to their anxiety and hopelessness, but unrelated to joy as well as learning outcomes.

4.2. SEM findings

The mediational SEM fit the data reasonably well ($\chi^2(63) = 97.37$, $p < .01$; CFI = 0.961, TLI = 0.936; RMSEA =0.078, 90%-CI [0.045, 0.108]; SRMR = 0.044). Partially corroborating H1, Fig. 1 (see Table 2 for full results) shows that T1 adaptability was positively related to T2 hope, and negatively related to anxiety and hopelessness, as expected, with all coefficients representing large effects in terms of magnitude, but not significantly related to joy (small positive effect). Contrasting H2, neither joy nor hope were significantly related to knowledge test scores (small and moderate positive effects, respectively). However, in line with H2, joy was positively related to perceived learning (large effect). Further supporting H2, anxiety was also negatively related to students' knowledge test scores at the end of the semester (large effect); however, it was not significantly negatively related to perceived learning based on one-sided testing (directed hypothesis; see Discussion for further interpretation). Hopelessness, in turn, was negatively related to perceived learning (large significant effect), but not significantly negatively

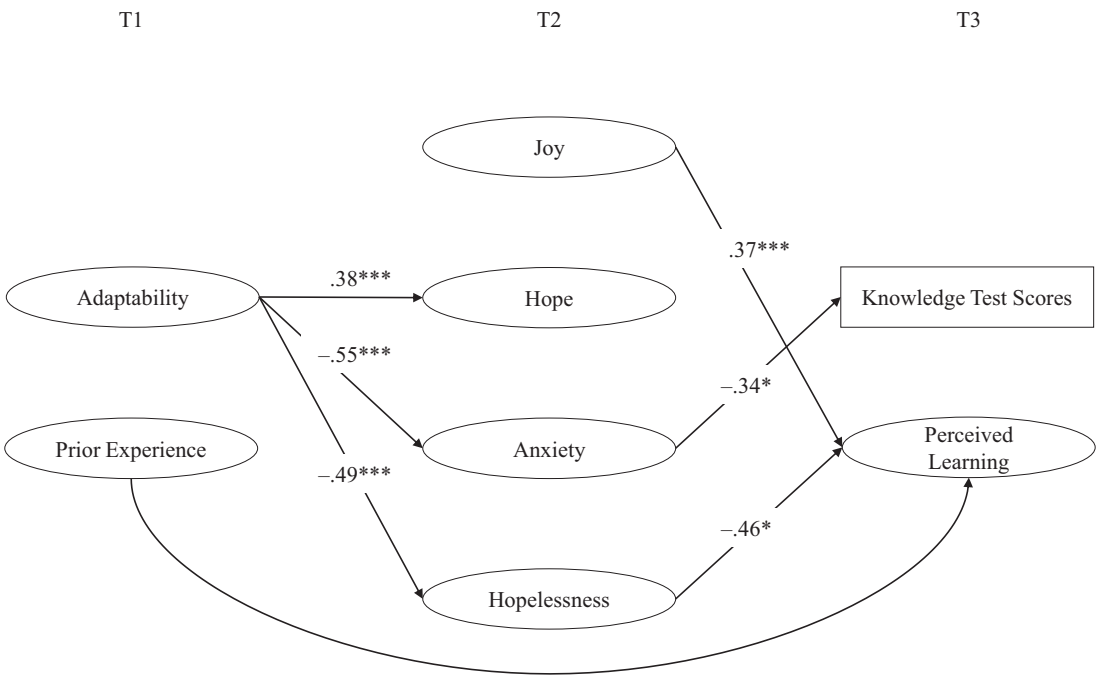

Fig. 1. Significant SEM results (direct effects).
Note. Only statistically significant paths for main (direct) effects based on our directional (one-sided) hypothesis tests are depicted. Correlations between adaptability and prior experience, between emotions, and between knowledge test scores and perceived learning were modeled but are not depicted for clarity. Likewise, indicators of the latent factors, loadings, and residuals are not visualized for clarity. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

related to knowledge test scores based on one-sided testing (directed hypothesis).

Further, adaptability did not significantly positively predict students' perceived learning and knowledge test scores directly based on one-sided hypothesis testing (H3). As for mediational effects (H4), we found that anxiety significantly mediated the indirect effect of adaptability on knowledge test scores (moderate effect). Hopelessness, in turn, mediated the link between adaptability and perceived learning (moderate effect). No further significant indirect effects linking adaptability with learning outcomes via emotions were found based on one-sided hypothesis testing. Finally, students' prior experience with digital courseware was positively related to their perceived learning (large effect), but not their emotions nor knowledge test scores.[4]

5. Discussion

COVID-19 imposed radical and sudden changes on instructional practice in higher education. In this study, we examined how students' individual capacity to adapt to uncertain and novel situations relates to their emotional experiences within a university course 'gone digital' due to the prevalent pandemic, and how these emotions relate to their learning outcomes within the course. Adaptability pertains to individuals' capacities to self-regulate behaviors, cognition, and affect specifically in response to situations involving uncertainty or novel experiences, such as that implied by the sudden shift to remote instruction in spring 2020. We sought to shed light on the impact of individual differences in students' preparedness to handle this major transition on their academic emotional experiences and learning outcomes, and consequently, to provide insight into which students may be particularly in need of support. Specifically, similar to Besser et al. (2020) and Zhang et al. (2021), the present research sought to study the role of student adaptability in a contextual setting which undoubtedly involved drastic changes and uncertainty in all areas of life, including educational realms.

To this end, expanding upon prior research on the role of adaptability in the current COVID-19 context (Besser et al., 2020), we employed a prospective longitudinal design involving three measurement time points throughout the spring 2020 semester which provided a clear temporal ordering of all study measures. In addition, we included both subjective (i.e., perceived learning) and objective indicators (i.e., knowledge test scores) of learning outcomes, and controlled for students' prior experience with digital courseware used in the target course. By way of our design, we were able to account for the fact that students' emotions are typically organized in course-/domain-specific ways (e.g., Goetz et al., 2007), which prior COVID-related research on undergraduates' adaptability has failed to address (Zhang et al., 2021).

5.1. Summary and discussion of findings

Our findings suggest that differences in students' adaptability indeed played a role for their emotions and learning outcomes in the first COVID-19 semester: Those students who perceived themselves as more apt in managing uncertain and novel situations (i.e., students attaining higher adaptability scores) experienced more hope, as well as less anxiety and hopelessness, partially supporting H1. These patterns support the assumption that adaptability may have helped students to negotiate and handle the changes, novelty, and uncertainty brought forth by the emergency remote teaching context in more emotionally adaptive ways. As outlined by Collie et al. (2017), more adaptable students are better equipped to handle uncertainty and ambiguity in low-control settings and respond effectively to situational/environmental challenges, which should predispose them towards more favorable perceptions of control and value targeting learning activities and outcomes that, in turn, elicit positive achievement emotions such as hope (cf. CVT; Pekrun, 2018). These deliberations are not only in line with, but also expand upon prior CVT-related research examining which, and how, individual differences impact students' achievement emotions.

[4] The findings regarding relations between adaptability, achievement emotions, and learning outcomes remained robust when considering students' preparedness for digital learning (see Section 3.1) as a covariate.

Table 2
Full SEM results (standardized coefficients) for the hypothesized main and mediational effects.

Predicted path	β	*SE*	*p*	95% CI	
				LL	UL
Adaptability → emotion					
Joy	0.15	0.16	0.176	−0.16	0.46
Hope	0.38***	0.13	0.002	0.13	0.63
Anxiety	−0.55***	0.12	0.000	−0.79	−0.31
Hopelessness	−0.49***	0.11	0.000	−0.71	−0.27
Emotion → knowledge test					
Joy	0.14	0.10	0.085	−0.06	0.34
Hope	0.23	0.14	0.056	−0.04	0.50
Anxiety	−0.34*	0.18	0.017	−0.69	0.01
Hopelessness	0.21	0.18	0.119	−0.14	0.56
Emotion → perceived learning					
Joy	0.37***	0.12	0.001	0.13	0.61
Hope	0.00	0.22	0.496	−0.43	0.43
Anxiety	0.45	0.21	0.014	0.04	0.86
Hopelessness	−0.46*	0.22	0.019	−0.89	−0.03
Adaptability → knowledge test	−0.28	0.19	0.009	−0.65	0.09
Adaptability → perceived learning	−0.10	0.13	0.221	−0.35	0.15
Adaptability → emotion → knowledge test					
Joy	0.02**	0.03	0.223	−0.04	0.08
Hope	0.09	0.06	0.073	−0.03	0.21
Anxiety	0.21*	0.11	0.034	−0.01	0.43
Hopelessness	−0.10	0.10	0.144	−0.30	0.10
Total indirect effect for knowledge test	0.21*	0.11	0.024	−0.01	0.43
Adaptability → emotion → perceived learning					
Joy	0.05	0.06	0.189	−0.07	0.17
Hope	0.00	0.08	0.496	−0.16	0.16
Anxiety	−0.25	0.13	0.024	−0.50	0.00
Hopelessness	0.22*	0.13	0.048	−0.03	0.47
Total indirect effect for perceived learning	0.03	0.21	0.412	−0.38	0.44
Prior experience → emotion					
Joy	−0.10	0.18	0.296	−0.45	0.25
Hope	0.13	0.27	0.169	−0.40	0.66
Anxiety	0.10	0.19	0.306	−0.27	0.47
Hopelessness	0.03	0.15	0.421	−0.26	0.32
Prior experience → knowledge test	−0.02	0.41	0.485	−0.82	0.78
Prior experience → perceived learning	0.30*	0.16	0.026	−0.01	0.61

Note. The placeholder 'emotion' refers to the different achievement emotions (i.e., joy, hope, anxiety, or hopelessness) assessed. Prior experience = prior experience with digital courseware. Intercorrelations among variables (e.g., among knowledge test scores and perceived learning) are not displayed. Reported are exact significance values (*p*) based on one-tailed testing. Confidence intervals are two-tailed.

* $p < .05$.
** $p < .01$.
*** $p < .001$.

In line with H2 and suggested by CVT, students' anxiety and hopeless were negatively related to their knowledge test scores and perceived learning, respectively, likely by way of compromising effective engagement with the learning material (Goetz & Hall, 2013; Pekrun, 2018). The magnitude of the coefficients reflects fairly substantial links between students' anxiety and their knowledge acquisition, corroborating prior research on this detrimental emotion (Goetz & Hall, 2013). It is interesting that anxiety was significantly related to our objective but not subjective learning outcome measure, while the opposite applied to hopelessness. When interpreting these findings, it should be noted that due to our formulation of directional hypotheses, we employed one-tailed testing to evaluate statistical significance of effects within the direction predicted in our hypotheses. As such, the seemingly positive relation between anxiety and perceived learning was not detected in our analyses. Using two-tailed testing, however, this relation would present a fairly surprising result that may be of interest to the field. In general, it may be possible that to a certain degree, anxiety led students to (subjectively) increase their efforts to avoid failure, increasing subsequent perceived learning gains; however, perceived learning did not translate to higher knowledge test scores for all learners. On a more conceptual level, one potential explanation for these differential relations between anxiety and objective versus subjective learning outcomes might be that students in the present sample had difficulties gauging their learning progress, as implied by the small but negative correlation between perceived learning and knowledge test scores. Moreover, the relatively small standard deviation for the perceived learning measure reflects little variation in students' subjective evaluation of their learning. This possibly points to difficulties in self-evaluation of achievement, generally resulting in less variation explained by students' emotions and preventing effects from emerging as statistically significant in the present research.

The fact that neither joy nor hope were significantly related to students' learning outcomes based on our SEM analyses contradicts H2. However, the (expected) positive relation between hope and knowledge test scores approached significance ($p = .056$). Furthermore, adaptability indirectly predicted students' knowledge test scores via anxiety, and students' perceived learning via hopelessness; as such, H3 was only partially supported. Again, due to one-sided testing of directional hypotheses, the seemingly significant, negative indirect effect linking adaptability with perceived learning via anxiety (resulting from the positive relation between anxiety and perceived learning as discussed above) was not of relevance to our interpretation of the findings (see Section 5.2 for further discussion).

Consequently, the present findings provide only partial support for our hypotheses. Of note, several coefficients generally aligned with our hypotheses in terms of direction of relations, but some of them failed to reach statistical significance within the present sample (see Section 5.2 below). For instance, the path coefficient linking adaptability and joy was positive ($\beta = 0.15$), but small to moderate in magnitude, and not statistically significant. Furthermore, the coefficients linking joy and hope with knowledge test scores were positive and small-to-moderate in magnitude ($\beta = 0.14$ and 0.21, respectively), but not statistically significant. These findings also imply that we may not have had sufficient power to detect these effects and that more research, ideally using larger samples, is needed to examine these relations in more depth. However, our simulation-based power analysis indicates sufficient power to detect at least moderate effects (see Section 3.4), suggesting confidence in our findings is warranted.

Moreover, the coefficients linking adaptability with hope, anxiety, and hopelessness were statistically significant and quite large in magnitude ($\geq|0.38|$). This is particularly noteworthy when considering that adaptability was conceptualized and measured as a context-unspecific (i.e., domain-general) individual disposition, whereas students' emotions were measured in relation to a specific course they were currently attending. Furthermore, both constructs were assessed at different timepoints (i.e., the beginning and middle of the semester, respectively), allowing for an interpretation of the temporal (but not necessarily causal) ordering of variables. These findings suggest that adaptability played an important role in students' learning-related emotions concerning their digital learning during the COVID-19 pandemic, and that less adaptable students in particular may need more support.

Unexpectedly, given our one-sided testing of directed hypotheses, adaptability was not directly (positively) related students' learning outcomes (H3), contrasting prior research on adaptability and academic achievement with secondary school students (Martin et al., 2012; Martin et al., 2015). A closer look at the extant literature reveals, however, that links between adaptability and academic outcomes may vary across educational settings as well as outcome variables considered. Collie et al. (2017) found that adaptability significantly predicted university students' academic (dis-)engagement, which in turn predicted their GPA

one semester later, but did not observe direct effects of adaptability on students' GPA. They did, however, observe indirect effects of adaptability on GPA via (dis-)engagement, leading the authors to reason that for tertiary-level students, adaptability may influence achievement in different ways. Zhang et al. (2021), in contrast, found Chinese university students' adaptability to directly their self-reported engagement as an outcome variable; however, they did not examine any objective indicators of achievement in their study, precluding direct comparison.

In the present research, two mediational effects were observed for anxiety and knowledge test scores, and hopelessness and perceived learning. From a statistical perspective, larger sample sizes might be needed to detect underlying mediational effects. From a conceptual-theoretical perspective, these findings may point to a need for incorporating additional explanatory variables to map out the functional pathways from adaptability to achievement outcomes (see also Zhang et al., 2021, for a discussion). Building on prior research, these could include measures targeting students' perceived control and value of learning activities and outcomes in terms of linking adaptability and achievement emotions (see Martin et al., 2015 for initial evidence on the mediational role of perceived control in linking adaptability and performance-related anxiety; see also prior research on the CVT, Pekrun, 2018). Furthermore, the mediational chain may also involve intermittent variables linking emotions and achievement, such as academic (dis-)engagement (see Collie et al., 2017), learning-related motivation, and cognitive-behavioral learning processes triggered by different achievement emotions.

5.2. Limitations and directions for future research

While the present study certainly has a number of strengths, several limitations need to be considered when interpreting its findings and deducing directions for future research. First, the present study is based on a relatively small sample of university students attending a specific university course. As such, we cannot speak to the generalizability of the present findings; rather, following Daniels et al. (2021) who took a similar approach to studying higher education students' motivation and engagement in relation to COVID-19 based on a small convenience sample, our findings provide an important snapshot of students' academic experiences. Nevertheless, our sample represents students from different teacher education programs and different subject domains offered at the site. Moreover, similar to the study by Daniels et al. (2021), the situatedness and proximity of the present research to students' actual experiences within a concrete university course may somewhat compensate for the narrow sample. However, future research should consider possibilities to replicate the present study using larger samples and examine replicability across different student populations.

Second, it should be noted that the present study drew on one-tailed significance testing. This decision was made a priori based on our formulation of directed hypotheses. As such, it is important to acknowledge the possibility that several effects may not have emerged as significant based on two-tailed testing. However, a closer consideration of the exact (two-tailed) significance values reported in Table 2 reveals that the majority of effects detected as significant using one-tailed testing would also have been significant under two-tailed testing conditions. This applies to relations between adaptability and emotions, between anxiety and knowledge test scores, and between enjoyment and perceived learning, in particular, with the indirect effects linking adaptability with learning outcomes via anxiety and hopelessness reaching marginal significance ($p < .10$). As such, our decision to conduct one-sided rather than two-sided testing did not systematically influence our findings.

Third, while the present study drew on a prospective-longitudinal design involving multiple measurement timepoints and thus allowed for a clear temporal ordering of our focal constructs, the data are correlational in nature and preclude causal inferences about the directions of impact. Moreover, we were unable to correct for potential auto-regressive effects of T1 emotions on T2 emotions within the present design. To shed more light on the mechanisms at play, future research should consider using more rigorous longitudinal designs involving assessments of all focal variables at multiple timepoints, which we were unable to implement given available resources (i.e., assessment time and course-based sample size). Furthermore, experimental designs could be employed in which students, for instance, are confronted with uncertainty and change to prime adaptability-related behaviors and emotions in controlled settings. The latter could also provide a means to examine adaptability 'in action' without having to rely solely on participants' self-reports, which should be considered for future assessment of achievement emotions as well.

Fourth, due to the nature and situational circumstances of the present study, no pre-COVID-19 comparison data on students' adaptability, course-related emotions, and learning outcomes within the target course under study is available. In a similar vein, we were unable to collect data from any comparative courses in spring 2020. However, such data could shed light on the degree to which the present findings are unique to their context of study (i.e., the first COVID-19-impacted semester involving exclusively digital learning), or whether they generalize across different settings. It is possible that the first full-on digital semester presented a particularly novel challenge to students, rendering individual differences in adaptability particularly salient and impactful for student outcomes. Consequently, collecting follow-up data using a study similar design under 'normal' (i.e., non-pandemic) learning conditions could provide insight into whether the observed patterns (and, for instance, the substantial relations between adaptability and students' hope, anxiety, and hopelessness) remain stable across study contexts and samples. However, as we conclude in Section 6, academic landscapes will likely continue to change in the future and, all other things being equal, we would expect the present results to generalize to future academic settings (see also Daumiller, Rinas, et al., 2021).

Fifth, on a more general level and as noted in the preceding section, the present findings imply a need for further examining the functional linkages among adaptability, achievement emotions, and learning outcomes. Using larger samples and longitudinal designs, future studies could examine the potential role of students' perceptions of personal control and value of learning in linking adaptability and emotions, as well as variables linking emotions and learning outcomes. Indeed, emerging research suggests that both the impact of adaptability on emotional-motivational constructs, as well as the impact of emotions on learning and achievement, are at least partially mediated by intermittent variables. Furthermore, it is possible, for instance, that instructional practices (e.g., teacher- vs. student-centered) afford different degrees of freedom for enacting self-regulatory processes underlying students' adaptation to uncertain academic situations, consequently impacting students' emotions and achievement. As such, future research should consider how specific characteristics of learning environments and teaching practices shape the relations under study. Incorporating these relations in future work can contribute to a deeper understanding of the functional mechanisms at play—a critical precondition for deducing sound principles for fostering students' academic and personal well-being in higher education.

5.3. Implications for educational practice

While the present findings only partially confirmed our hypotheses, they do bear several important implications for educational practitioners and policy makers. Specifically, they point to the importance of supporting students in navigating new educational terrains, especially those with low adaptability who may be particularly at-risk for struggling emotionally and academically. We suggest three main ways to provide such support to students.

First, considering the specific pandemic context of the present research, one important approach to intervening and providing effective support to students pertains to reducing uncertainty related to

emergency remote teaching, and digital learning more generally, within higher education settings, as well as by promoting digital competencies in both students and instructors. Indeed, as noted in the Introduction section, 'digitalization' in higher education has generally been fairly slow to emerge, and the OECD itself contends that embracing digital tools and possibilities for increasing the impact and flexibility of learning and teaching practices in the 21st century and beyond should be a prime 'lesson learned' from the current crisis (OECD, 2020). Preparing students for using digital courseware, promoting adaptive attitudes towards digitally-enhanced learning, and providing sufficient opportunities to interact with teachers as well as fellow students should help reduce feelings of uncertainty or helplessness (see also Besser et al., 2020; Händel, Bedenlier, et al., 2020), particularly for those students with low adaptability who may otherwise be prone to experiencing more negative achievement emotions. While this undertaking may appear somewhat daunting, it seems that the time for embracing digital educational opportunities is more than ripe, and the current context has led many institutions to acquire new tools and strategies, and educators to develop new didactic concepts for digital instruction, that can be harnessed and built upon in this endeavor.

Second, promoting student adaptability by means of adaptability interventions should generally benefit students both emotionally and academically. The present findings further highlight the need for developing such interventions to build students' capacities for coping with uncertainty and change encountered as part of their academic lives more generally, beyond the radical and abrupt transformation of higher education brought forth by the current pandemic (see also Section 6). Martin et al. (2013; Martin et al., 2015; see also Collie et al., 2017; Holliman et al., 2018) suggest that adaptability can be boosted using similar approaches as those designed to foster resilience and handle (academic) 'setbacks'. Major steps include 1) teaching students to recognize uncertainty and novelty that may require regulatory responding; 2) teaching students how to appropriately adjust their behaviors, cognitions, and emotions in relation to the current circumstances and given available resources; and 3) encouraging students to recognize the importance of regulatory responding, as well as monitoring and refining their responding as needed. Research developing and evaluating such programs is still lacking, however, and their effectiveness remains to be determined. Nevertheless, scholars and practitioners can draw on emerging research focusing on related constructs such as promoting effective self-regulation, for instance, with regard to emotional experiences (e.g., Quoidbach et al., 2015) and adjust these approaches to target different academic situations involving uncertainty and change students may encounter over the course of their studies. Such efforts may help students develop flexibility in thought-action repertoires that facilitates adaptive responses to changing environments, but supporting empirical evidence is needed.

Third, related to the notion of fostering students' emotion regulation to combat experienced negative emotions, particularly by learners with low adaptability, offering direct emotional support to students could be beneficial. Emotional support targeting achievement emotions can take on many different forms and target different stages of the emotion-generative process. In line with step 2) suggested for adaptability interventions as outlined above, one important skill for students to acquire pertains to their ability to reappraise situational circumstances and uncertainty in such a way that it is perceived as less threatening and promotes perceived control (i.e., using self-instruction; see, Harley et al., 2019, for an overview of achievement emotion regulation).

Furthermore, in line with recent findings showing that students' lack of connectedness with fellow students as well as teachers negatively impacted their social-emotional experiences and learning during the spring 2020 semester (Besser et al., 2020; Händel, Bedenlier, et al., 2020; Schober et al., 2020), provision of emotional support could also consider drawing on providing opportunities for communication and exchange with peers and instructors, not just in relation to course content or assignments, but also with regard to their current emotional experiences and struggles. The importance of social relatedness for students' well-being is well-established, and might be more important than ever to consider during the current circumstances and learning conditions. More generally, the provision of emotional support to students by instructors and/or institutional counseling varies (e.g., Rueckert, 2015); developing (digitally) accessible services and actively reaching out to students could be worthwhile endeavors.

6. Conclusion

Within the current COVID-19 pandemic and its highly dynamic implications for individuals' personal, occupational, and academic lives, the ability to adapt to uncertainty and novelty seems to constitute a key capacity. As Martin (2017a) contends, adaptability can be seen as a critical skill in today's rapidly changing world more generally, that is, beyond the current crisis, but (educational) research has mostly been devoted to how individuals deal with adversity and setbacks, rather than change and uncertainty. The present study contributes to the growing body of research on student adaptability and shows that this skill is indeed important for student outcomes in higher education, including achievement emotions that have not been studied in conjunction with adaptability to date, and which, in turn, shape student learning and achievement. While more research is needed to pin down the mechanisms by which adaptability can impact student outcomes, the findings show that fostering student adaptability and preparing them for future challenges involving uncertainty, novelty, and change, is pivotal for promoting personal and academic well-being in higher education.

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