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Students' basic needs and well-being during the COVID-19 pandemic: A two-country study of basic psychological need satisfaction, intrinsic learning motivation, positive emotion and the moderating role of self-regulated learning

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COVID-19 and its containment measures have uniquely challenged adolescent well-being. Following self-determination theory (SDT), the present research seeks to identify characteristics that relate to well-being in terms of positive emotion and intrinsic learning motivation under distance schooling conditions and whether SDT's core postulates hold true in this exceptional situation. Feeling competent and autonomous concerning schoolwork, and socially related to others were hypothesised to relate to positive emotion and intrinsic learning motivation. The role of self-regulated learning (SRL) as a moderator was considered. Self-reports were collected from 19,967 secondary school students in Austria (Study 1) and Germany (Study 2). In both studies, structural equation modelling revealed that all basic needs were associated with positive emotion, and that competence and autonomy were associated with intrinsic learning motivation. Moderation effects of SRL were identified in Study 1 only: The association of autonomy and both outcomes and the association of competence and intrinsic learning motivation varied with the level of SRL. The results highlight the relevance of basic psychological need satisfaction and SRL in a situation in which adolescents are confronted with a sudden loss of daily routines.

Keywords: Distance schooling; COVID-19; Self-determination theory; Well-being; Adolescence.

In light of the COVID-19 pandemic, most countries in the world instituted temporal national school closures in March 2020 to contain the spread of the disease. Students worldwide have been facing a fundamentally altered situation not only with respect to schooling, but with respect to their lives as a whole, due to the variety of protective measures instituted. There is a large body of evidence on the high secondary costs of school

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JH participated in the design and coordination of the study. She performed and interpreted the statistical analyses with ML and drafted the manuscript. ML conceived of the study and its design, conducted and interpreted statistical analyses with JH and drafted the results section of the manuscript. UK, ASK and SW coordinated the study in Germany and contributed to the final version of the manuscript. SK and EP participated in the design and coordination of the study and contributed to the final version of the manuscript. CS and BS conceived of the study and its design and contributed to the final version of the manuscript. All authors read and approved the final manuscript.

closures, especially with regard to psychosocial harm and economic disruptions, both of which disproportionately affect vulnerable populations (Berkman, 2008). Not only the threat of the disease itself, but also the associated containment measures have created unique challenges for adolescent well-being in terms of positive emotion and psychological functioning. Given these risks and challenges, the present research aims to identify psychological characteristics that relate to adolescents' well-being during unplanned and involuntary distance schooling instead of the regular school context. Following self-determination theory (SDT; Deci & Ryan, 2000), we investigate the role of basic psychological need satisfaction for students' well-being in terms of positive emotion and intrinsic learning motivation and whether SDT's core postulates hold true during the exceptional situation of the COVID-19 pandemic.

Self-determination theory

SDT (Deci & Ryan, 2000) focuses on the concept of basic needs, proposing that satisfaction of the basic psychological needs for competence, autonomy, and relatedness represent core conditions for psychological well-being, independent of context. Within SDT, psychological well-being is understood as consisting of both hedonic and eudaimonic well-being. Whereas hedonic well-being refers to well-being as an outcome in terms of positive emotions, eudaimonic well-being refers to a process of pursuing intrinsic goals and values for their own sake (i.e. intrinsic motivation; Deci & Ryan, 2008; Ryan et al., 2008). Therefore, according to SDT, the basic psychological needs for competence, autonomy, and relatedness are considered essential for psychological well-being both in terms of positive emotion and intrinsic motivation.

The need for competence refers to experiencing one's behaviour as effective. For instance, students feel competent when they are able to meet the challenges of their schoolwork. The need for autonomy refers to experiencing one's behaviour as volitional and self-endorsed. For example, students feel autonomous when they themselves choose to devote time and energy to their school-related tasks. Finally, relatedness refers to the desire to feel connected with and experience mutual support from significant others. SDT states that well-being cannot be achieved without addressing the basic needs, as they represent innate psychological nutriments, influencing regulatory processes towards humans' most effective functioning (Deci & Ryan, 2000).

To date, numerous studies have empirically supported SDT's basic assumptions in adults as well as adolescents and across different life domains (León et al., 2015; Van den Broeck et al., 2016). In addition, SDT has been frequently applied in the educational context, and students' basic need satisfaction has been successfully targeted by educators in schools (e.g. Reeve & Jang, 2006).

Distance schooling and basic need satisfaction in times of COVID-19

To follow-up on students' learning processes during the COVID-19 pandemic, schools worldwide have introduced various remote teaching solutions, in this study referred to as distance schooling. Findings on distance learning in general report both advantages and challenges. One major advantage and challenge simultaneously lies in the individualised learning aspect. On the one hand, distance learning may provide learners with ample opportunities to practice and apply what they are learning at their own pace (Paechter & Maier, 2010) and hence experience autonomy. There is consistent evidence that individualised, autonomous learning environments create optimal conditions for learners to experience themselves as competent (Niemiec & Ryan, 2009). According to SDT, both autonomy and competence are necessary conditions to develop and maintain intrinsic motivation (Ryan & Deci, 2000). On the other hand, self-paced, individualised learning requires the learner to be able to handle flexibility. A large-scale survey among pupils in German-speaking countries shortly after the COVID-19 school closings revealed that not all students were able to cope with distance learning equally well (Huber et al., 2020). While some considered it positive to be able to learn at their own pace, others had problems structuring their day and their tasks, and those who were better able to plan their day and tasks were more engaged in learning. In conclusion, distance schooling might require learners to practice greater self-regulated learning (SRL). According to Huber et al. (2020), goal setting and planning one's own learning process represent particularly important aspects of SRL with respect to the distance schooling situation.

Another major challenge of distance schooling lies in the physical separation, resulting in limited spontaneous interaction. It is therefore crucial to explicitly address learners' individual needs, feelings, and difficulties in distance learning environments. Moreover, feeling connected to others has been shown to strongly relate to academic success in traditional as well as distance learning environments (e.g. Furrer & Skinner, 2003; Giesbers et al., 2014) and to contribute to psychological well-being (e.g. Jose et al., 2012). This highlights the potential relevance of maintaining social contacts during the COVID-19 pandemic, whether with schoolmates or with significant others from out-of-school contexts.

The present research

In light of the risks and challenges of the COVID-19 pandemic, the present study investigates the role of basic psychological need satisfaction for adolescents' well-being in terms of positive emotion and intrinsic learning motivation and whether SDT's core postulates hold true in

this exceptional situation. Recognising the importance of schooling as a central context for adolescents, the study focuses on the distance schooling situation. Comprising data from Austria (Study 1) and Germany (Study 2), the present research takes a multi-study approach. In order to investigate whether the evidence is consistent across both countries, we first collected data in Austria and then conducted a follow-up study in Germany.

Following SDT, well-being is understood as consisting of hedonic as well as eudaimonic aspects. We therefore include both positive emotion and intrinsic learning motivation, to operationalise adolescents' psychological well-being. Based on previous findings, we assume that all three basic needs, namely competence, autonomy and relatedness, relate to positive emotion and intrinsic learning motivation (Hypotheses 1a and 1b). However, available evidence (e.g. Huber et al., 2020) suggests that experiencing autonomy as well as competence in a distance learning setting might be influenced by learners' self-regulation, especially with regard to setting goals and planning one's learning process. We therefore expect that the associations between experienced competence and positive emotion as well as between experienced autonomy and positive emotion will be moderated by SRL in terms of goal setting and planning (Hypotheses 2a and 2b). Similarly, we hypothesise that the associations between experienced competence and intrinsic learning motivation as well as between experienced autonomy and intrinsic learning motivation will be moderated by SRL in terms of goal setting and planning (Hypotheses 2c and 2d).

Previous findings on positive emotion and intrinsic learning motivation found that older adolescents experience lower levels of positive emotion (e.g. Ronen et al., 2016) and intrinsic learning motivation (e.g. Gnambs & Hanfstingl, 2016). Thus, we used participants' age as a control variable in our models.

METHOD

Participants, procedure and data collection context

The overall sample comprised 19,967 secondary school students (37.7% males, 61.8% females, 0.5% diverse) with a mean age of 14.59 years ($SD = 2.51$, Mdn = 15.00, Range = 10–21). In both studies, data were collected via online questionnaires in spring 2020. To recruit the sample, we distributed the link to the online questionnaire by contacting diverse stakeholders such as school boards, educational networks and school principals. Additionally, in Austria (Study 1), the Federal Ministry for Education, Science and Research published the study link and recommended participation on its website. Before being forwarded to the items, participants were informed about the study's goals, the approximate duration of the questionnaire, inclusion criteria for participation, that is, attending secondary school in the respective country, and the complete anonymity of their data. All students participated voluntarily and only those who gave active consent were included in the dataset.

Study 1 — Austria

The sample comprised 19,337 secondary school students (37.9% males, 61.6% females, 0.5% diverse) with a mean age of 14.56 years ($SD = 2.49$, Mdn = 14.00, Range = 10–21). The students stemmed from secondary schools all over Austria. Data were collected from April 7 to April 24. In Austria, schools stopped providing onsite learning on March 16. During the entire period of data collection, schools were obliged to ensure continued education by providing distance schooling. Teachers and schools were given autonomy in the organisation and design of remote teaching.

Study 2 — Germany

The sample comprised 630 secondary school students (30.4% males, 69.1% females, 0.5% diverse) with a mean age of 15.73 years ($SD = 2.76$, Mdn = 16.00, Range = 10–21). The students stemmed from secondary schools in the most-populous German federal state (North Rhine-Westphalia). Data were collected from May 5 to June 11. Schools in North Rhine-Westphalia were closed from March 16 until April 19. During this time, individual teachers and schools were responsible for organising distance learning. A careful reopening of schools began on April 20. Consequently, most pupils attended in-person classes once a week and learned at home the remaining days. Only fourth graders and upper secondary school students attended school more frequently.

Measures

Due to the novelty of the COVID-19 situation, it was necessary to adapt existing scales or develop new items in order to address the current circumstances. To ensure content validity of the adapted or newly formulated items, we revised them based on expert judgements from members of our research group. In a next step, the measure was piloted with cognitive interview testing among three adolescents. To ensure the construct validity of the finally implemented measures, we conducted confirmatory factor analyses (CFA) and analysed composite reliability (CR). All items were rated on a 5-point scale ranging from 1 (strongly agree) to 5 (strongly disagree). Participants were instructed to answer the items with respect to the current situation (learning from home due to the

coronavirus pandemic). We conducted the analyses with recoded items so that higher values reflected higher agreement with the statements.

Competence was measured with three items adapted from the Work-related Basic Need Satisfaction Scale (W-BNS; Van den Broeck et al., 2010). We adapted the work-related items to the school context (sample item: "These days I am able to successfully complete most of my schoolwork"). The scale's CR was .85 for Study 1 and .85 for Study 2.

Autonomy was assessed with three newly developed items that addressed the extent to which students felt that they could approach studying in a way that suited them best (sample item: "Currently, I can decide on my own how I want to approach studying"; CR = .76/.75).

Relatedness was measured with three items that were slightly adapted from the connectedness subscale of the EPOCH Measure of Adolescent Well-Being (Kern et al., 2016). In contrast to competence and autonomy, the items targeting relatedness did not refer to the school context, but to significant others in general (sample item: "When something good happens to me, I have people who I tell about it"; CR = .83/.83).

Self-regulated learning in terms of goal setting and planning one's learning process was assessed with three items, slightly adapted from the short version of the Learning Strategies of University Students questionnaire (LIST-K; Klingsieck, 2018; sample item: "When I am currently studying, I make a plan of what I need to do"; CR = .77/.83).

Positive emotion was measured with two items from the Scale of Positive And Negative Experience (SPANE; Diener et al., 2010; "I feel good," "I feel content") and one item adapted from the optimism subscale of the EPOCH Measure of Adolescent Well-Being (Kern et al., 2016; "Even though things are tough right now, I think everything will be okay"; CR = .86/.85).

Intrinsic learning motivation was assessed with three items adapted from the Scales for the Measurement of Motivational Regulation for Learning in University Students (SMR-LS; Thomas et al., 2018; sample item: "Currently, I really enjoy studying and working for school"; CR = .92/.89).

Data analysis

Data were analysed using SPSS version 25.0 and Mplus version 8.4. Statistical analyses were conducted using CFAs and structural equation models (SEMs) with latent interactions. To deal with the very small number of missing values (ranging from 0.1 to 0.3% on the item level), the full information maximum likelihood approach implemented in Mplus was employed. All statistical significance testing was performed at the .05 level. However, due to the large sample, rather than relying on statistical significance, we particularly focused on the identified effect sizes for the regression parameters when interpreting the results. In doing so, we followed Cohen's (1988) recommendations, according to which standardised values of .10, .30 and .50 reflect small, moderate and large effect sizes, respectively.

First, CFA using robust maximum likelihood estimation (MLR) were conducted to analyse the construct validity of the scales. Goodness-of-fit was evaluated using χ^2 test of model fit, CFI, TLI, RMSEA and SRMR. We considered typical cutoff scores reflecting excellent and adequate fit to the data, respectively: (a) CFI and TLI > 0.95 and 0.90; (b) RMSEA and SRMR <.06 and .08 (Hu & Bentler, 1999).

Second, we tested for the measures' measurement invariance across both studies (country of data collection). CFAs (one each for the predictors, the moderator, and the outcomes) were set up to investigate the dimensionality of the scales. Moreover, we tested for measurement invariance (configural invariance, metric invariance, scalar invariance) across countries by calculating a set of increasingly constrained CFAs. While configural invariance tests whether the same factor structure is valid for each group, metric invariance implies that students in both countries attribute the same meaning to the latent constructs. If the assumption of scalar invariance holds, the meaning of the levels of the underlying items is equal in both groups (van de Schoot et al., 2012). We followed Chen's (2007) recommendations when evaluating the measurement invariance assumptions. Accordingly, when the sample size is adequate ($N > 300$), declines in CFI > .01 and increases in RMSEA > .015 are indicative of meaningful changes in model fit that would make the assumptions of measurement invariance not tenable. Additionally, we compared the BIC values of the models, with smaller values indicating a better trade-off between model fit and model complexity (see van de Schoot et al., 2012). For all three models, which were measured on 5-point Likert-type scales, the MLR estimator was used for the CFAs.

Third, we set up two models to test main effects and latent interactions in both studies (Maslowsky et al., 2015). Model 0 tested the main effects of the three basic psychological needs and SRL on positive emotion and intrinsic learning motivation. In Model 1, we added latent interactions between competence and SRL as well as between autonomy and SRL. Appropriately specified latent-interaction models include both main-effect variables and the product term (Cohen, 1978). Additionally, we compared the relative fit of Model 0 and Model 1 using a log-likelihood ratio test. A significant log-likelihood ratio test indicates that Model 0 represents a significant loss in fit compared to the more complex Model 1 (Satorra, 2000).

TABLE 1
Bivariate latent correlations, descriptive statistics and composite reliabilities for both Studies

	1	*2*	*3*	*4*	*5*	*6*	*7*
1. Competence	—	.46	.38	.49	.63	.67	−.11
2. Autonomy	.55	—	.20	.30	.37	.39	−.06
3. Relatedness	.44	.28	—	.31	.39	.13	−.04
4. Self-regulated learning	.49	.33	.28	—	.25	.38	−.08
5. Positive emotion	.69	.46	.49	.30	—	.50	−.16
6. Intrinsic learning motivation	.66	.46	.26	.45	.57	—	−.05
7. Age	−.16	−.06	−.12	.06	−.19	−.09	—
Study 1—Austria							
Number of items	3	3	3	3	3	3	—
M	3.78	4.04	4.54	4.10	3.97	2.84	14.56
SD	0.92	0.97	0.75	0.92	0.94	1.15	2.49
Skewness	−0.75	−0.99	−2.03	−1.07	−0.96	0.04	0.12
Kurtosis	0.21	0.37	4.10	0.66	0.45	−0.91	−0.90
Range	4.00	4.00	4.00	4.00	4.00	4.00	11
Composite reliability	.85	.76	.83	.77	.86	.92	—
Study 2—Germany							
Number of items	3	3	3	3	3	3	—
M	3.43	3.73	4.39	3.83	3.66	2.45	15.74
SD	0.94	1.01	0.80	1.04	0.95	1.03	2.76
Skewness	−0.43	−0.61	−1.49	−0.82	−0.57	0.36	−0.07
Kurtosis	−0.19	−0.33	1.89	0.05	−0.21	−0.54	−0.77
Range	4.00	4.00	4.00	4.00	4.00	4.00	11
Composite reliability	.85	.75	.83	.83	.85	.89	—

Note: N_{Study1} = 19,337 students, N_{Study2} = 630 students. All scales used a 5-point response format. Correlations for Study 1 (Austria) are below the diagonal and correlations for Study 2 (Germany) above the diagonal. All correlation coefficients > |.056| are statistically significant at $p < .05$.

Compliance with ethical standards

All procedures performed were in accordance with 1964 Helsinki declaration and its later amendments or comparable ethical standards. Moreover, the study complies with the ethical standards of the Federal Ministry for Education, Science, and Research who approved of the study. Participation in the study was completely voluntarily. Before being forwarded to the items, participants were informed about the study's goals, approximate duration of the questionnaire, inclusion criteria for participation, and the complete anonymity of their data. Only those who gave active consent were included in the dataset. The study was carried out in accordance with the European General Data Protection Regulation.

RESULTS

Preliminary analyses

Table 1 provides bivariate latent correlations among all variables as well as descriptive statistics and composite reliabilities in both samples.

Confirmatory factor analyses and measurement invariance testing

The results of the CFA models revealed excellent fit indices for all scales for both Study 1, χ^2 (120) = 4059.23, $p < .001$, CFI = .973, TLI = .965, RMSEA = .041, SRMR = .032, and Study 2, χ^2 (120) = 244.99, $p < .001$, CFI = .975, TLI = .968, RMSEA = .041, SRMR = .039. The tests for measurement invariance showed that scalar invariance could be established for all variables based on Chen's (2007) recommendations as well as because the scalar invariance model had the lowest BIC value (see van de Schoot et al., 2012). The SRL scale consisted of three items. In such cases, the configural invariance model is always saturated, with fit indices revealing a "perfect fit." Hence, with such a baseline model, evaluating changes in fit indices is not a useful strategy to determine measurement invariance. Instead, we focused here on the BIC values. Comparing the BIC values of the three models indicated that the scalar invariance model had the best fit. All results of the measurement invariance testing are reported in Table 2.

Main effects and latent interactions of basic needs and SRL on positive emotion and intrinsic learning motivation

To investigate the main effects of basic needs and SRL on students' positive emotions and intrinsic learning motivation, two SEMs were conducted for the two studies (Model 0_1 and Model 0_2). The effect of age on the outcome variables was controlled for. The model estimation revealed that all three basic psychological needs were positively associated with positive emotion in both studies.

TABLE 2
Measurement invariance testing across countries for the confirmatory factor analytic measurement models for basic psychological needs, self-regulated learning, intrinsic learning motivation, and positive emotion

Model	χ^2	*df*	*CFI*	*RMSEA*	*BIC*	*Model description*
Basic psychological needs (competence, autonomy, relatedness)	677.488*	48	0.989	0.036	435, 982.360	Configural invariance
	682.318*	54	0.989	0.034	435, 928.946	Metric invariance
	725.460*	60	0.988	0.033	435, 905.452	Scalar invariance
Self-regulated learning	0.000	0	1.000	0.000	160, 074.265	Configural invariance
	1.428	2	1.000	0.000	160, 056.043	Metric invariance
	1.574	4	1.000	0.000	160, 036.317	Scalar invariance
Outcomes (intrinsic learning motivation, positive emotion)	568.255*	16	0.990	0.059	297, 770.811	Configural invariance
	586.839*	20	0.990	0.053	297, 738.839	Metric invariance
	604.548*	24	0.989	0.049	297, 706.281	Scalar invariance

Note: Please note that the model for self-regulated learning had only three factor indicators (items) and the configural invariance model was thus saturated; χ^2 = chi square test of model fit; CFI = comparative fit index; RMSEA = root mean square error of approximation; BIC = Bayesian Information Criterion. $^*p \leq .001$.

TABLE 3
Path coefficients of the main effects (Model 0_1) and latent-interaction models (Model 1_1) for Study 1

	Model 0_1			*Model* 1_1		
Outcome and predictor	*Est. (SE)*	*SE*	*p*	*Est. (SE)*	*SE*	*p*
Positive emotion						
Competence	0.66 (0.01)	0.55	<.001	0.66 (0.01)	0.55	<.001
Autonomy	0.12 (0.01)	0.11	<.001	0.13 (0.01)	0.11	<.001
Relatedness	0.29 (0.01)	0.22	<.001	0.29 (0.01)	0.22	<.001
SRL	−0.06 (0.01)	−0.06	<.001	−0.06 (0.01)	−0.05	<.001
Competence × SRL				−0.01 (0.01)	−0.01	.633
Autonomy × SRL				0.04 (0.02)	0.03	.009
R^2	0.52			0.53		
Intrinsic learning motivation						
Competence	0.74 (0.01)	0.53	<.001	0.76 (0.02)	0.53	<.001
Autonomy	0.17 (0.01)	0.13	<.001	0.19 (0.01)	0.13	<.001
Relatedness	−0.10 (0.01)	−0.61	<.001	−0.09 (0.01)	−0.05	<.001
SRL	0.21 (0.01)	0.17	<.001	0.27 (0.01)	0.21	<.001
Competence × SRL				0.15 (0.01)	0.09	<.001
Autonomy × SRL				0.06 (0.01)	0.04	<.001
R^2	0.47			0.53		
Goodness of fit						
AIC	843,815.075			843,350.296		
BIC	844,373.829			843,940.529		

Note: SRL = Self-regulated Learning; Est. = unstandardized parameter estimate; Std. Est. = standardised estimate; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion. Model 0_1 showed an excellent model fit, CFI = .963, TLI = .953, RMSEA = .046, SRMR = .044.

Competence, autonomy and SRL were positively associated with intrinsic learning motivation, whereas SRL did not significantly relate to intrinsic learning motivation in Study 2 (see Table 3 for Study 1 and Table 4 for Study 2). Competence proved to relatively relate more strongly to positive emotion and intrinsic learning motivation; the path coefficients for competence were larger than those for autonomy, relatedness and SRL. In addition to descriptively comparing the coefficients, we tested the differences in regression slopes for the basic psychological needs for each outcome variable for statistical significance using the MPlus Model Constraint command. All regression slopes in both studies, except for those between autonomy and positive emotion and between relatedness and positive emotion in Study 2, were statistically significantly different from each other.

To investigate moderation effects of SRL on students' outcomes, latent interactions (competence × SRL; autonomy × SRL) were added to Model 0 for both studies. In Study 1, statistically significant positive latent interactions between autonomy and SRL emerged for positive emotion, b* = 0.03, *SE* = 0.02, *p* = .009, and for intrinsic learning motivation, b* = 0.04, *SE* = 0.01, $p < .001$. Moreover, the competence and SRL interaction on intrinsic learning motivation was statistically significant in Study 1, b* = 0.09, *SE* = 0.01, $p < .001$ (see Model 1_1 in Table 3). The association of autonomy and both outcomes as well as the association of competence and

TABLE 4
Path coefficients of the main effects (Model 0_2) and latent-interaction models (Model 1_2) for Study 2

	Model 0_2			*Model 1_2*		
Outcome and predictor	*Est. (SE)*	*SE*	*p*	*Est. (SE)*	*SE*	*p*
Positive emotion						
Competence	0.62 (0.07)	0.56	<.001	0.63 (0.07)	0.56	<.001
Autonomy	0.13 (0.06)	0.11	.029	0.13 (0.06)	0.11	.026
Relatedness	0.22 (0.05)	0.19	<.001	0.23 (0.05)	0.19	<.001
SRL	−0.12 (0.05)	−0.13	.016	−0.12 (0.05)	−0.12	.017
Competence × SRL				0.04 (0.07)	0.04	.573
Autonomy × SRL				−0.04 (0.09)	−0.03	.673
R^2	0.44			0.45		
Intrinsic learning motivation						
Competence	0.74 (0.08)	0.64	<.001	0.76 (0.08)	0.65	<.001
Autonomy	0.13 (0.06)	0.11	.020	0.14 (0.06)	0.11	.016
Relatedness	−0.20 (0.06)	−0.16	<.001	−0.20 (0.06)	−0.16	<.001
SRL	0.09 (0.05)	0.09	.062	0.10 (0.05)	0.10	.036
Competence × SRL				0.05 (0.05)	0.04	.290
Autonomy × SRL				0.08 (0.06)	0.06	.171
R^2	0.48			0.52		
Goodness of fit						
AIC	28,666.903			28,665.865		
BIC	28,982.549			28,999.294		

Note: SRL = self-regulated learning; Est. = unstandardized parameter estimate; Std. Est. = standardised estimate; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion. Model 0_1 showed an excellent model fit, CFI = .974, TLI = .967, RMSEA = .039, SRMR = .043.

intrinsic learning motivation varied with the level of SRL. In other words, the associations between competence and autonomy and the outcomes increased, as the moderator increased. Johnson-Neyman plots, depicting these interactions, are provided within the Figure S1 (Supporting Information).

The relative fit of Model 1_1 versus Model 0_1 was determined via a log-likelihood ratio test, yielding a significant log-likelihood difference of D (4) = 472.778, $p < .001$. This result indicates that the null model represents a significant loss in fit relative to Model 1_1. Model 1_1 should therefore be kept for Study 1 (see Figure 1). Moreover, both AIC and BIC values were higher for Model 0_1 than for Model 1_1, and the explained variance for both outcomes yielded higher values of R^2 in Model 1_1 than in Model 0_1.

In Study 2, no statistically significant latent interactions were found (see Model 1_2 in Table 4). Accordingly, the log-likelihood ratio test was not significant, with D (4) = 9.04, indicating that the null model does not represent a significant loss in fit relative to Model 1_2. Model 0_2 is therefore kept for Study 2 (see Figure 2).

Finally, we conducted post-hoc power analyses using the pwrSEM package for R (Wang & Rhemtulla, 2020), which showed that an equal sample size in Study 2 as in Study 1 would have led to comparable statistical power to detect moderation effects except for the moderation effect of autonomy with SRL on positive emotion. With the given sample size of Study 2, probabilities to detect the moderation effects in the specified Model 1 were close or equal to zero.

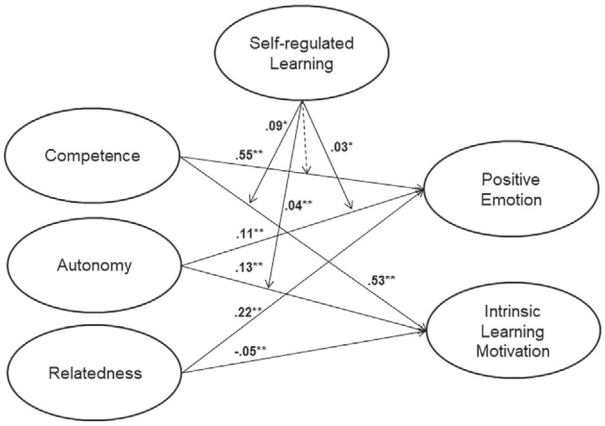

Figure 1. Structural equation model predicting positive emotion and intrinsic learning motivation (Study 1—Model 1_1). *Note*: This SEM predicts students' positive emotion and learning motivation from their basic psychological needs, with moderating effects of self-regulated learning. Statistics are standardised regression coefficients. Dotted lines represent non-significant relations. $*p < .01$ $**p < .001$.

DISCUSSION

The present research investigated associations between basic psychological need satisfaction and students' well-being in terms of positive emotion and intrinsic learning motivation in the exceptional situation of the COVID-19 pandemic, and whether SDT's core postulates hold true during unplanned and involuntary distance schooling, considering SRL as a moderator.

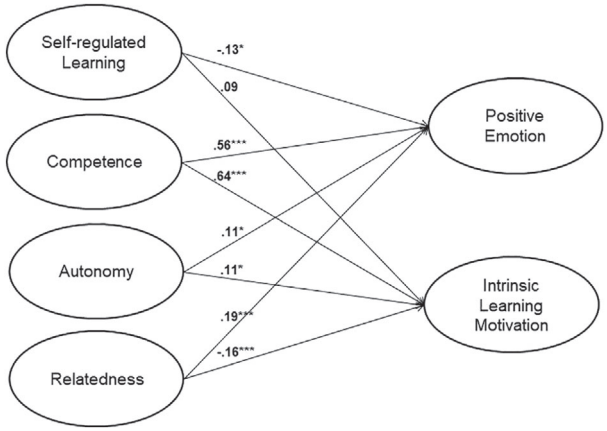

Figure 2. Structural equation model predicting positive emotion and learning motivation (Study 2—Model 0_2). *Note*. This SEM predicts students' positive emotion and learning motivation from their basic psychological needs and self-regulated learning. Statistics are standardised regression coefficients. Dotted lines represent non-significant relations. $^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$.

To investigate whether the evidence is consistent across countries, we took a multi-study approach and collected data in Austria (Study 1) and Germany (Study 2).

In line with Hypothesis 1a and SDT's basic assumptions (Deci & Ryan, 2000), all three basic needs, namely competence, autonomy, and relatedness, were associated with positive emotion in both studies. Regarding Hypothesis 1b, we only found competence and autonomy to positively relate to intrinsic learning motivation in both studies. Relatedness was negatively associated with intrinsic learning motivation in both Study 1 and Study 2. The very small effect sizes, however, do not allow for a conclusion on the practical relevance of these effects.

The expected moderation effects of SRL on the relationship between autonomy and competence and the outcomes were inconsistent. Our analyses revealed no statistically significant interaction between SRL and competence on positive emotion (Hypothesis 2a). For the interaction between SRL and autonomy on positive emotion, we only found a statistically significant interaction in Study 1. For the moderation effect of SRL on the relationships between experienced competence and intrinsic learning motivation as well as between experienced autonomy and intrinsic learning motivation, we found significant, but minor to small effects in Study 1 only (Hypotheses 2c and 2d). Although the interactions were not consistently statistically significant, it should be noted that the main effects of SRL on both outcomes were partly statistically significant. The identified effect sizes speak in favour of the relevance of SRL for intrinsic learning motivation, while small negative effects on positive emotion were revealed. These results indicate that an abundance of SRL might also negatively relate to positive emotions.

The results of the analyses were broadly consistent across both Study 1 and Study 2, providing convergent evidence across countries. The results are further supported by the identified scalar measurement invariance, showing that the meaning of the levels of the underlying items were equal in both countries. Moreover, the high proportions of explained variance, ranging from 44 to 53%, should be particularly noted. The high explanatory power of our models and the large sample size are substantial strengths of this research and underline SDT's applicability, even in exceptional situations. Nevertheless, there are some findings that are surprising at a first glance. While competence and autonomy were statistically significantly related to both outcomes, relatedness was associated with positive emotion, but negatively with intrinsic learning motivation. This could be explained by the fact that both the measures for relatedness and positive emotion were not specified as school-related. Since SDT's assumptions are context-sensitive (Deci & Ryan, 2000), it seems less surprising that general relatedness was not positively associated with intrinsic learning motivation. Moreover, associations of autonomy with positive emotion and intrinsic learning motivation were less salient than expected. This could be explained by the specific situation of the pandemic where autonomous learning might be overwhelming due to a loss of structure and routines. This notion is supported by the partially identified moderation effects of SRL.

Limitations and future directions

Despite the large sample and high proportion of explained variance, the present research is limited in some respects. First, the results rely on self-reports. While this is common practice for most of the constructs examined, there are concerns regarding the validity of self-report instruments assessing SRL (e.g. Winne et al., 2002). Second, data were collected online. This can be seen as a limitation of our studies, as the sample was self-selected and participants could not be supervised. The self-selection also led to an overrepresentation of females in the sample. In addition, the samples sizes of Study 1 and Study 2 differed greatly, leading to inequivalent statistical power to detect main and moderating effects. A further limitation relates to the fact that our data collection method required participants to read and comprehend texts at an adequate level, and to have internet access and a device at their disposal. Accordingly, we have to assume that disadvantaged students are less represented in the sample. Finally, the cross-sectional design of our studies is a limitation, as it limits our ability to make causal inferences. It needs to be pointed out that the conceptual model of the assumed relations was established based on theoretical assumptions. Our results support these assumptions, but do not provide evidence for causal effects.

Consequently, we recommend that follow-up studies incorporate further informants (e.g. teacher and parent ratings, observations) in order to obtain a clearer picture. This especially relates to the role of SRL. Future research should also consider different data collection approaches to ensure a better representation of the population in terms of age, gender, and disadvantaged groups. In particular, the collection of longitudinal data should be considered to further substantiate the evidence for the large effects found. Finally, it would be profitable to explicitly consider the multilevel structure of the data (students in classes, classes in schools) to identify possible context effects. This could not be controlled for in this study, due to the anonymisation of the data.

CONCLUSION

The present research illustrates the relevance of basic psychological need satisfaction for adolescent well-being in terms of positive emotion and intrinsic learning motivation in times of crisis. This speaks in favour of SDT's claim for universality, even in exceptional situations. Moreover, the results indicate that associations between competence, autonomy and the outcome variables may depend on students' engagement in SRL.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Figure S1. The Johnson-Neyman Plots (Johnson & Neyman, 1936) show the interaction effect of (a) autonomy × goals and plans on learning motivation, (b) competence × goals and plans on learning motivation, (c) autonomy × goals and plans on positive affect, (d) competence × goals and plans on positive affect for Study 1 (Austria). Both the fixed factor method and the effect coding method were used to be able to show the interaction effect with the original metric (1–5).

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