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ARTICLE

Motivational development in times of campus closure: Longitudinal trends in undergraduate students' need satisfaction and intrinsic learning motivation

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Abstract

Aims: Higher education systems around the world have enforced campus closures to combat the COVID-19 pandemic. Such measures may threaten students' basic psychological needs for relatedness, competence and autonomy, and the development of intrinsic learning motivation. Little is known about whether the implementation of campus closures yielded negative developmental patterns for these motivational variables. We aim to close this research gap.

Sample: We investigated developmental patterns in longitudinal data spanning the first four semesters of undergraduate students in two cohorts at one German university starting in 2013 and 2019 (cohort 1: normal study conditions; cohort 2: affected by campus closure). We used propensity score modelling to ensure comparability between both cohorts resulting in a sample of 435 students each (total $n = 870$ students).

Method: We estimated conditional latent growth curve models (LGCM) to investigate developmental trends in need satisfaction and intrinsic learning motivation across the students' first four semesters and how these trends differed between the two cohorts.

Results: The results indicated a more maladaptive development of motivational variables for students of cohort

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2 compared to students of cohort 1. More specifically, we found negative developmental trends following the implementation of campus closures for competence, relatedness and intrinsic learning motivation.

Conclusions: Our findings highlight the importance of considering side effects for students' psychological functioning when discussing the implementation or renewal of campus closures. It seems important to find ways to carefully reopen higher education institutions while also minimizing further risks for students and faculty.

KEYWORDS

basic psychological needs, campus closures, intrinsic learning motivation, motivational development

INTRODUCTION

The COVID-19 pandemic affected students in higher education institutions severely. The first series of lockdowns was accompanied by worldwide closures of universities and an unprecedented switch to online teaching and remote learning (Marinoni et al., 2020). Some countries (e.g. Germany, Canada and Israel) maintained an enforced full nationwide closure of physical campuses starting in March 2020 and continuing for the remainder of 2020. As of 1 February 2021, 50% of all OECD countries still maintained closures of physical campuses (OECD, 2021a), while no OECD country had fully reopened higher education institutions. These measures have been stricter than for primary (30 per cent of countries fully open) or secondary education (24 per cent of countries fully open at the same time point; OECD, 2021b). It stands to reason that the prolonged campus closures especially impacted freshmen students' psychological functioning on fundamental levels as their transition into higher education was strongly characterized by drastic externally imposed regulations. In line with self-determination theory (Ryan & Deci, 2017), we argue that the affected students experienced difficulties in aligning their new learning environment at university with their basic psychological needs for autonomy, competence and relatedness. Initial cross-sectional studies already highlighted the centrality of students' basic psychological needs for their learning motivation during the pandemic (Holzer et al., 2021; Martinek et al., 2021). We aim to advance this research by supplementing it with longitudinal data that allow for (a) the investigation of developments in need satisfaction and learning motivation of freshmen over the time of the campus closures and (b) the detection of deviations in this development from prior student cohorts. Insights into such developmental trends further our understanding about whether and how the campus closures disturbed a normal transition process into university.

Basic psychological needs as building blocks of students' psychological functioning

To understand how campus closures may have impacted the trajectory of students' motivation, it is crucial to identify which factors facilitate optimal psychological development under normal conditions. Valuable insight to this end is proffered by self-determination theory (SDT), one of the most influential macro-theories on human functioning (Ryan & Deci, 2017, 2019). A main tenet of this theory is that humans share three basic psychological needs for autonomy (striving for experiences of self-reliance), competence (striving for experiences of mastery) and relatedness (striving for experiences of genuine human

connection; Vansteenkiste & Ryan, 2013). If individuals feel that their environment is suitable to satisfy these basic needs, they will experience well-being (Milyavskaya & Koestner, 2011; Ryan et al., 2008) and start to develop interest for activities bound to the respective environment (Deci & Ryan, 2008).

For university students, the experience of need satisfaction is particularly important during their first years at university. In this phase of uncertainty, students establish new social connections to peers and aim to affirm their fit within their new environment (Holmegaard et al., 2014; Meehan & Howells, 2019; Pym et al., 2011). Research indicates that supporting students' need satisfaction (particularly for autonomy and relatedness) during this critical transition phase predicts academic adjustments in terms of lowered dropout intentions as well as enhanced performance and well-being (Girelli et al., 2018; Walton & Cohen, 2011). Furthermore, need support in learning environments at university is generally linked to reduced distress (Gilbert et al., 2021), adoption of learning goals (Ciani et al., 2011) and the development of subsequent well-being in terms of nostalgic memories (Janke et al., 2021). In sum, this means that need support provides the foundation for an adaptive development of students' psychological functioning. Against this background, it can be argued that campus closures could have shaken this foundation to the core as they present a unique threat to need satisfaction.

Campus closures as disruptive force for need satisfaction

There is an emerging body of empirical evidence showing that central tenets of SDT also hold true under the unusual conditions that followed the COVID-19 pandemic (for a broad perspective, see Rudert et al., 2021). For the higher education sector, researchers found that need satisfaction was associated both with intrinsic learning motivation and well-being of students in Austria, Finland and Germany during the time of campus closures (Holzer et al., 2021; Martinek et al., 2021; Teuber et al., 2021). These findings are of interest for the generalizability of SDT to extraordinary circumstances. However, the existing literature falls short in explaining whether students' experiences of need satisfaction differed during the campus closures compared to normal study conditions. This is because the published findings merely rely on cross-sectional samples that lack a comparison group of students that were not affected by campus closures. It is, thus, unclear whether the campus closures were associated with a negative development of students' need satisfaction.

We argue that the often hastily implemented online learning environments may have threatened students' abilities to satisfy their basic psychological needs. While some have claimed that the implemented online learning increased students' autonomy to shape their learning environment (Eberle & Hobrecht, 2021), it remains unclear whether students truly experienced this change as meaningful freedom or rather as an externally imposed restriction. Additionally, it stands to reason that developing relatedness became more difficult for freshmen due to the campus closures. Students in their first year find themselves in a new and often foreign social environment after enrolling at university. Normally, freshmen will quickly find new friends among their new peers who attend the same lectures, share meals in the same cafeteria and go to the same social events. Consequently, the first years at university can be seen as a phase when friendships develop by chance due to physical proximity (Back et al., 2008). However, the development of such social bonds requires social interactions before, between and after formal learning activities. In a time when students were not physically present during lectures, social interaction before and after classes was severely restricted. Additional social activities on- and off-campus were also often strongly restricted due to the campus closures. Thus, the enforced campus closures may have disrupted the development of social connections between students.

Finally, we want to highlight that the implemented shift to digital teaching also likely impacted learning processes. Many instructors had to change established teaching concepts from on-site to digital teaching within weeks or even days with many educators being unprepared for such a shift (Alemany-Arrebola et al., 2020). This did not only challenge instructors, who, as a result, often experienced psychological strain (Daumiller et al., 2020) but also their students who had to rely more strongly on their ability to self-regulate learning processes (Hamdan et al., 2021; Lestari et al., 2020). As freshmen are

typically less skilled in managing self-regulated learning processes than students of higher semesters (Vosniadou, 2020), the way to mastery may have become steeper and more challenging for them in times of online learning. We expect this to be reflected in an impaired development of feelings of competence.

Our reflections on the potential of campus closures impacting need satisfaction are mirrored in research conducted prior to the pandemic. Particularly, researchers have shown that students experience both impaired need satisfaction and reduced intrinsic motivation in online compared to on-site university courses (Filak & Nicolini, 2018). First qualitative research suggests similar trends for students enrolled during the pandemic, particularly regarding relatedness (Eberle & Hobrecht, 2021).

The assumed maladaptive development of need satisfaction might go along with further motivational consequences. SDT states that need satisfaction is directly linked to the development of intrinsic learning motivation (Goldman et al., 2017; Karimi & Sotoodeh, 2019). Intrinsic learning motivation describes students' ability to engage in learning out of interest and/or enjoyment and can be further differentiated from more extrinsically regulated forms of learning motivation (motivation through external reward systems such as the wish to attain good grades; Ryan & Deci, 2020). Intrinsic motivation will flourish if (a) basic psychological needs are satisfied (Goldman et al., 2017; Karimi & Sotoodeh, 2019) and (b) individuals are not exposed to restricting external forces (Ryan & Deci, 2017). Given that campus closures may have strongly restricted need satisfaction of students due to a set of externally imposed rules, it seems likely that the development of intrinsic learning motivation was also impaired for the affected students.

Research objectives

The main objective of our research is to investigate developmental trends in need satisfaction within a sample of students that transitioned into higher education in the critical period of the pandemic. We aim to detect irregularities in the development of students' basic psychological needs after the implemented campus closures by comparing longitudinal data from an affected student cohort with longitudinal data collected under normal study conditions. We particularly expect that the development of need satisfaction for relatedness, competence and autonomy, as well as the development of intrinsic learning motivation were impaired following the campus closures. While theorists have proposed to further differentiate between impaired need satisfaction and need frustration (e.g., Vansteenkiste & Ryan, 2013), we expect that campus closures both reduced need satisfaction and enhanced need frustration and as such did not further differentiate between these factors. We also investigate whether the assumed negative development in need satisfaction yields stable group differences during a prolonged period of campus closures, whether need satisfaction and intrinsic learning motivation adjusted over time or whether the development worsened.

METHOD

We used two data sets to investigate our research questions. The data sets were collected at the same German university to monitor the development of undergraduate students' motivation during their first years at university. In both cases, all undergraduate students of one cohort were contacted through the university administration at the beginning of each semester over the course of their first four semesters at university, which resulted in four time points (beginning of the first, second, third and fourth semesters). Participation in the study was voluntary and informed consent was obtained for all participants.

The first data set was collected in the cohort starting in 2013 under normal study conditions. The development of basic psychological needs had already been investigated priorly within this cohort (Janke, 2022). This informs us of developmental patterns for need satisfaction that should be expected at this

specific university. The data suggested an increase in feelings of relatedness and competence as well as a decrease in feelings of autonomy over time. The detrimental development of autonomy has been attributed to students' expectation about academic freedom being confronted by the reality of restricting external forces such as high stakes testing and grading.

The second data set taps into the experiences of the cohort starting in 2019 and has not yet been analysed regarding the development of need satisfaction. This cohort was affected by campus closures midway into their second semester. This means that the first time point (T1) can be interpreted as a normal entrance phase. The second time point (T2) in turn only reflects the very onset of lockdown measures as it took place between March and April 2020. The local campus closure was first implemented in the final weeks of March followed by a regular Easter term break in April. Thus, most participants were either unaffected by these measures or had not been subject to online learning for an extended period yet (data collection ended midway into the Easter term break). Conversely, participants had been subject to campus closures for half a year at the third time point (October 2020; T3) and for a full year at the fourth time point (March 2021; T4). The respective university did not revoke campus closures or resume on-site teaching within the time of measurement.

Sample

Overall, 521 students from the 2013 cohort and 649 students from the 2019 cohort provided full data sets at the first time point.¹ Both samples are unrepresentative convenience samples accounting for about 25 per cent of the total student population. Thus, it was necessary to ensure that the derived data from the samples were not biased regarding the investigated variables or other factors such as an overrepresentation of certain majors in one of the samples. We used propensity score modelling to reduce such bias in age, gender, parental educational background, high school GPA, study programme, need satisfaction at T1 and intrinsic learning motivation at T1.

We constructed a propensity score logistic regression model using the MatchIt package in R (Ho et al., 2011) with the cohort (2013 vs. 2019) as the dependent variable and the aforementioned covariates (age, gender, subject, parental educational background, T1 autonomy, competence, relatedness and intrinsic learning motivation). Following recommendations by Austin (2014), we used nearest-neighbour calliper matching without replacement as matching method. A total of 435 students from each cohort could be matched to ideal pairs. Investigation of the absolute standardized mean differences showed that differences in the considered covariates were reduced substantially between the two cohorts (see Figure 1). This was also reflected in Welch two-sample t-tests that pointed to little differences between the two cohorts in the matched data (all $p > .08$).

The remaining students were enrolled in majors in the fields of business administration, computer sciences, economics, humanities, law, mathematics and social sciences (see Table 1 for further information on demographics). On average, the remaining students participated at 2.5 time points ($SD = 1.2$ time points). More specifically, 29.2 per cent of the full sample participated at four time points, 19.0 per cent at three time points, 23.9 per cent at two time points and 27.9 per cent only at the first time point. To test for systematic attrition effects bound to the variables of interest, we conducted additional MANOVAs for all three time points including 'participation at this time point' and 'cohort membership' as independent variables predicting need satisfaction and intrinsic learning motivation measured at T1 as dependent variables. We neither found general systematic attrition effects (all $p > .05$) nor cohort-specific attrition effects (indicated by the interaction between both IVs; all $p > .28$).

¹Given that all students of a cohort were contacted through the university administration at the beginning of each semester instead of just those who participated at T1, the total samples of students participating at any time point were larger ($n = 1056$ for the 2013 cohort and $n = 1280$ for the 2019 cohort). However, as accurate propensity score modelling requires full data sets, we only used the data of participants who had participated at T1.

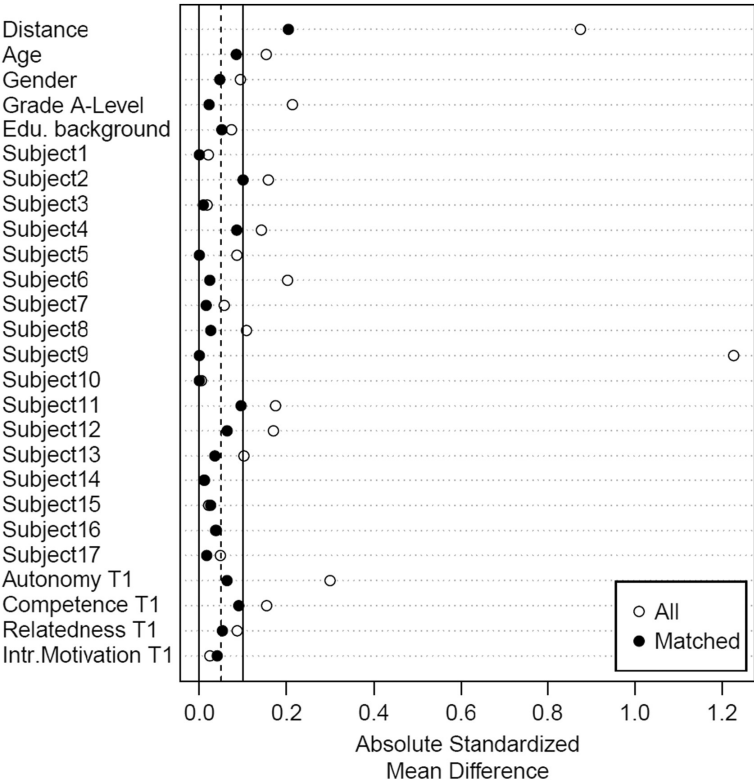


FIGURE 1 Differences between the two cohorts before and after propensity score matching

Measurements

Need satisfaction

The degree of need satisfaction was measured with a German translation of the *Balanced Measure of Psychological Needs Scale* (see Sheldon & Schöler, 2011). This scale indicates need satisfaction for each need with three positively worded items and three negatively worded items. Prior research in the 2013 cohort suggested that further distinguishing need frustration (indicated by the negatively worded items) from need satisfaction does not yield differential effects (Janke, 2022). Therefore, we aggregated positive and negative items into one general score for need satisfaction. All items were targeted at the higher education context (sample items for autonomy: ‘In my current situation at university, I am free to do things my own way.’; competence: ‘In my current situation at university, I am successfully completing difficult tasks and projects.’ and relatedness: ‘In my current situation at university, I feel close and connected with other fellow students who are important to me.’) and assessed with a Likert scale ranging from 1 (*total disagreement*) to 7 (*total agreement*). All three subscales reached sufficient internal consistency over all four measurement points (smallest α at any time point = .68).

We found slight differences in the wording of single items between the two cohorts. While these deviations mostly reflected semantical changes, one item measuring frustration of relatedness differed severely. This item was excluded from all analyses. Another deviation was that the items for relatedness had a different reference group at T1 (*‘persons who care about me’*) compared to the other time points (*‘fellow students who care about me’*) within the 2013 cohort but not in the 2019 cohort, for which the items referred to *‘fellow students’* at all time points.

TABLE 1 Descriptive statistics of the sample after propensity score matching

Cohort	2013			2019		
Variable	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
Age	435	19.76	2.00	435	19.58	1.93
Gender ^a	435	.62	.49	435	.60	.49
High School GPA ^b	435	1.82	.62	435	1.83	.62
Parental education background ^c	435	.64	.48	435	.61	.49
Need satisfaction and motivation (T1 = First Semester)						
Autonomy	435	4.73	.83	435	4.79	1.00
Competence	435	5.20	.88	435	5.26	1.13
Relatedness	435	5.14	.77	435	5.12	.79
Intrinsic learning motivation	435	5.29	.95	435	5.33	1.14
Need satisfaction and motivation (T2 = Second Semester)						
Autonomy	273	4.60	.86	246	4.82	.97
Competence	273	4.93	.92	246	4.79	1.06
Relatedness	273	5.54	.96	246	5.33	1.18
Intrinsic learning motivation	273	5.31	1.04	246	5.25	1.15
Need satisfaction and motivation (T3 = Third Semester)						
Autonomy	218	4.42	.90	186	4.58	1.03
Competence	218	4.98	.96	186	4.69	1.12
Relatedness	218	5.52	1.05	186	5.02	1.24
Intrinsic learning motivation	216	5.26	1.05	186	5.13	1.31
Need satisfaction and motivation (T4 = Fourth Semester)						
Autonomy	191	4.34	.92	186	4.54	1.05
Competence	191	5.02	.94	186	4.78	1.06
Relatedness	191	5.58	.98	186	4.85	1.23
Intrinsic learning motivation	190	5.16	1.09	187	5.08	1.32

Note: The presented values for intrinsic learning motivation and need satisfaction represent manifest data and not the estimations derived from later growth curve modelling. The estimated values are presented in Table 3.

^aMeans reflect percentage of female students.

^bScale: 1 (very good) to 4 (sufficient).

^c0 = no academic degree; 1 = at least one parent with academic degree.

Intrinsic learning motivation

Intrinsic learning motivation was measured with six items. The items were adapted from the Intrinsic Motivation Inventory (IMI; Deci & Ryan, 2013) and generally focus on interest and enjoyment as core aspects of intrinsic motivation (sample item: ‘*I think studying is really interesting.*’; a full depiction of all items can be found as open material under <https://osf.io/wc4v7>). It was measured on a 7-point Likert scale with responses ranging from 1 (*not at all*) to 7 (*completely true*). The scale reached sufficient internal consistency over all four measurement points (smallest α at any time point = .92) and there were no deviations in item wording between the cohorts.

Analyses

We conducted latent growth curve models (LGCM) to investigate the intercept and slope in students' need satisfaction and intrinsic learning motivation. An important prerequisite for LGCM is measurement

invariance of the respective scales, which indicates whether responses to survey items reflect the same constructs across time and between groups (Putnick & Bornstein, 2016). To test the measurement invariance for our scales, we estimated (a) a model in which item-factor clusters were set as equivalent for all groups/time points (configural invariance), (b) a model in which the factor loadings were restricted between the groups/time points (metric invariance) and (c) a model in which the thresholds were additionally restricted (scalar invariance). We controlled for methodological variance bound to item wording (positively/negatively worded) either by introducing factors indicating item modality or by introducing residual correlations if fewer than three items were worded in a certain way (only the case for relatedness). After establishing scalar invariance, we conducted separate LGCM for each basic psychological need as well as for intrinsic learning motivation. We investigated both general linear and quadratic trends. These developmental trends were then regressed on cohort membership to detect group differences in the development of the investigated constructs over time.

We conducted our analyses with the package lavaan in R using the maximum likelihood estimator with robust standard errors (MLR) as estimator and full information maximum likelihood imputation (FIML) to handle missing data. Missing data emerged due to attrition between time points (see Table 1) but (with the exception of four single data points due to early termination of the questionnaire) not within time points due to the application of forced response items. The model fit of all computed models is reported according to the recommendations by Hu and Bentler (1999): We used a combination of misfit (SRMR, RMSEA) and fit indices (CFI, TLI) and distinguished between an acceptable model fit ($\text{SRMR} \leq .10$, $\text{RMSEA} \leq .08$, $\text{CFI} \geq .95$, $\text{TLI} \geq .95$) and a good model fit ($\text{SRMR} \leq .05$, $\text{RMSEA} \leq .05$, $\text{CFI} \geq .97$, $\text{TLI} \geq .97$; see Schermelleh-Engel et al., 2003). Slight deviations from the depicted thresholds ($\Delta < .02$) were tolerated if the overall pattern indicated an acceptable-to-good fit. Regarding invariance testing, we considered a deterioration of $\text{CFI} \geq .010$ and $\text{RMSEA} \geq .015$ or $\text{SRMR} \geq .010$ (for metric invariance: $\text{SRMR} \geq .030$; see Chen, 2007). The data and input files are available as open materials at <https://osf.io/wc4v7>.

RESULTS

Our preliminary analysis into measurement invariance supported configural invariance across measurement points with $\chi^2(365) = 2387.11$, $p < .001$, $\text{SRMR} = .03$, $\text{RMSEA} = .05$, $\text{CFI} = .96$, $\text{TLI} = .94$. Further analyses did not yield sufficient evidence for a violation of metric invariance ($\Delta\text{SRMR} = .003$, $\Delta\text{RMSEA} < .001$, $\Delta\text{CFI} = .003$, $\Delta\text{TLI} < .001$) and of scalar invariance ($\Delta\text{SRMR} = .003$, $\Delta\text{RMSEA} = .004$, $\Delta\text{CFI} = .008$, $\Delta\text{TLI} = .008$). We also found indication for configural invariance between both cohorts with $\chi^2(712) = 2519.78$, $p < .001$, $\text{SRMR} = .03$, $\text{RMSEA} = .05$, $\text{CFI} = .96$, $\text{TLI} = .95$, as well as for metric invariance ($\Delta\text{SRMR} = .003$, $\Delta\text{RMSEA} < .001$, $\Delta\text{CFI} = .001$, $\Delta\text{TLI} < .001$) and scalar invariance ($\Delta\text{SRMR} = .001$, $\Delta\text{RMSEA} = .001$, $\Delta\text{CFI} = .003$, $\Delta\text{TLI} = .002$).

The results of the LGCMs are depicted in Table 2. A closer inspection of the depicted trends yielded three central insights: First, cohorts did not differ in their intercepts, which underlines that the propensity score matching indeed resulted in two comparatively similar samples regarding the baseline of need satisfaction and intrinsic learning motivation. Second, the satisfaction of all needs but autonomy increased over time. For intrinsic learning motivation, the development was characterized by a quadratic development with initial gains and a later decline between the third and fourth semesters. Third, three of four linear trends differed between the two cohorts. Specifically, the development of competence, relatedness and intrinsic learning motivation was impaired in the 2019 cohort compared to the 2013 cohort. We did not find any indication for similar trends regarding autonomy. The developmental trends for both cohorts are depicted in Figures 2a–d.

Further post-hoc inspections of the growth curve parameters at the different time points revealed differential developmental trends for the observed variables (see Table 3). We observed the most detrimental development for relatedness, which in general increased in the 2013 cohort, whereas it continuously decreased in the 2019 cohort. We even found first group differences at the initial onset of

TABLE 2 Results of the latent growth curve models

	Autonomy	Competence	Relatedness	Intrinsic motivation
Intercepts of growth parameters				
Intercept	4.67***	4.64***	5.15***	5.24***
Linear trend	-.34**	.24***	.81***	.27*
Quadratic trend	.04	— ^a	-.16**	-.10*
Variances of growth parameters				
Intercept	.45	.48	.67	.71
Linear trend	.06	.05	.43	.13
Quadratic trend	.01	<.0001 ^a	.04	.01
Standardized effect of cohort (2019 = 1 vs. 2013 = 0) on growth parameters				
Intercept	.07	.04	.06	.05
Linear trend	.13	-.27***	-.43**	-.22**
Quadratic trend	-.03	— ^a	.06	.06*
χ^2	10.84	18.3	10.6	1.32
<i>df</i>	2	7	2	2
<i>p</i>	.004	.003	.005	.536
CFI	.989	.981	.989	>.999
TLI	.946	.972	.945	>.999
SRMR	.020	.032	.019	.007
RSMSEA	.069	.047	.071	<.001

Note: Presented are standardized effects based on the propensity score matched data of students from the 2013 and 2019 cohort ($N = 435$ each).

^aGiven that there was no substantial amount of variability for the quadratic trend, we removed the slope from the model to provide a more accurate estimation of the other parameters.

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

lockdown measures during the second semester, which became stronger over time. For feelings of competence, the group differences between the cohorts were mostly driven by the relative stagnation of the variable in the 2019 cohort (compared to an increase in the 2013 cohort). Intrinsic learning motivation exhibited increasing group differences between the second and the third semesters, which vanished between the third and fourth semesters (reflected in the significant effect of cohort membership on the quadratic trend). Finally, while both cohorts largely showed parallel development in autonomy, we found that a stronger decline in feelings of autonomy in the 2013 cohort at the start of the second semester manifested itself in group differences that remained stable over time.

DISCUSSION

In the presented study, we compared the development of need satisfaction and intrinsic learning motivation over the first four semesters of undergraduate students who had been affected by campus closures during the COVID-19 pandemic and students of a prior cohort. Through propensity score modelling, we ensured that both cohorts were comparable in a wide variety of student characteristics. We found that students who were affected by campus closures experienced impaired development in feelings of relatedness (small-to-medium effect sizes with $d = .39-.78$) and competence (small-to-medium effect sizes with $d = .12-.42$) at university compared to their counterparts in the prior cohort. This could mean that the investigated undergraduates were vulnerable to side effects of prolonged campus closures. For them, it may have become more difficult to connect with fellow students and structure their learning progress. This rather maladaptive development of need

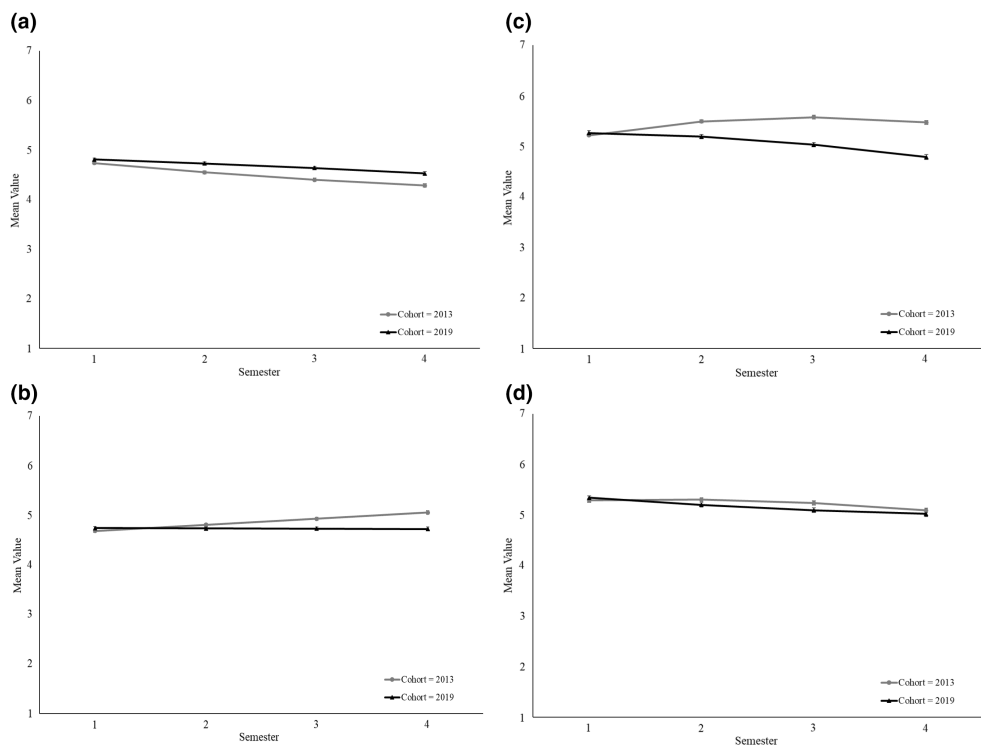


FIGURE 2 Growth curves for the development of (a) feelings of autonomy; (b) feelings of competence; (c) feelings of relatedness; (d) intrinsic learning motivation

satisfaction resonated with the initial negative development of intrinsic learning motivation which attenuated over time. While the observed effect sizes for intrinsic learning motivation do not exceed the traditional thresholds for small effects ($d > .20$), it should be kept in mind that minimal effects observed in the field can already have considerable impact on educational processes (McCartney & Rosenthal, 2000).

Implications of the conducted research

There is an emerging body of research into the importance of need satisfaction for students during the COVID-19 pandemic (Holzer et al., 2021; Martinek et al., 2021). However, little is known about whether undergraduate students experienced impaired development of need satisfaction following campus closures. From our findings, we can infer that the shift to remote learning and online teaching interfered with students' basic psychological needs as well as with the development of their intrinsic learning motivation. A closer look at our results allows for a finer grained picture regarding students psychological functioning as we observed differential developmental trends for the three needs.

For perceived autonomy, we found no conclusive evidence for maladaptive developments that could be attributed to campus closures. Even though feelings of autonomy generally declined over time in both cohorts, we did not observe any acceleration of this trend in the 2019 cohort after the implementation of lockdown measures. While we have argued that campus closures imposed external restrictions on students that diminish feelings of autonomy, other researchers have claimed that the new learning conditions increased students' ability to autonomously shape their learning environment (Eberle & Hobrecht, 2021). Our nil findings do not necessarily mean that either assumption is untrue. In contrast,

TABLE 3 Post-hoc inspection of estimated means derived from the growth curves

	2013 cohort		2019 cohort		Group differences		
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>p</i>	<i>d</i>
Autonomy							
T1	4.73	.55	4.81	.59	$t(868) = -1.90$	.057	-.07
T2	4.55	.64	4.73	.69	$t(868) = -4.02$	<.001	-.27
T3	4.40	.69	4.64	.72	$t(868) = -4.97$	<.001	-.34
T4	4.28	.69	4.53	.75	$t(868) = -5.02$	<.001	-.34
Competence							
T1	4.69	.56	4.74	.59	$t(868) = -1.42$	.157	-.10
T2	4.81	.60	4.74	.65	$t(868) = 1.70$	.089	.12
T3	4.93	.66	4.73	.73	$t(868) = 4.23$	<.001	.29
T4	5.05	.74	4.72	.82	$t(868) = 6.20$	<.001	.42
Relatedness							
T1	5.22	.43	5.26	.95	$t(868) = -.91$	.364	-.06
T2	5.49	.66	5.19	.88	$t(868) = 5.76$	<.001	.39
T3	5.57	.76	5.03	.90	$t(844.22) = 9.70$	<.001	.66
T4	5.47	.77	4.79	.98	$t(824.86) = 11.42$	<.001	.78
Intrinsic learning motivation							
T1	5.29	.79	5.34	.73	$t(863.41) = -1.01$	.314	-.07
T2	5.30	.77	5.20	.86	$t(868) = 1.82$	.068	.12
T3	5.24	.82	5.09	.96	$t(846.31) = 2.34$	.019	.16
T4	5.10	.83	5.02	1.08	$t(815.66) = 1.07$	.296	.07

Note: The depicted mean values are estimates based on the conducted growth curve models. The values deviate slightly from the manifest values depicted in Table 1 because we used the full information of the data set to estimate the values (FIML procedure) rather than just relying on the data of the respective time point.

our findings could indicate that experienced external regulation as well as new found opportunities for self-determined action impact students' experience of autonomy resulting in opposing effects that cancel each other out. Furthermore, even if the imposed changes increased autonomy, students may have lacked the necessary self-regulation abilities to make use of this newly introduced academic freedom. It would be interesting to follow up on this notion in further studies on how students construe autonomy in times of externally imposed remote learning.

The result pattern for feelings of competence was more clear-cut. The overall positive development of competence experiences was impaired in the 2019 cohort. More specifically, we found stagnation in feelings of competence in the aftermath of the implementation of campus closures. This could indicate that it was difficult for students to facilitate experiences of mastery given the new and challenging learning conditions. However, the absence of a decrease in feelings of competence in the 2019 cohort may also reflect that students of this cohort learned to cope with remote learning over time, which could have least partially protected their self-efficacy (Hamdan et al., 2021; Lestari et al., 2020). One caveat of our research is that our data only allow to investigate experienced competence, but not the impact of campus closures on the actual acquisition of skills and knowledge, which may be an interesting research objective for further studies (for a pioneer study, see Klug & Seethaler, 2021).

The development of students' relatedness shows the most concerning picture within the participating undergraduate students of the affected cohort. Relatedness not only declined in the 2019 cohort following the campus closures but the disparities between the two cohorts even increased another half year later with relatedness showing further decrease in the 2019 cohort. This indicates that a shift to remote learning may have particularly strong implications for students' striving to connect with their peers.

From a practical perspective, our results underline that the enforcement of campus closures in higher education institutions may come with clear psychological costs, especially for students' feelings of competence and relatedness. Members of faculty and the administration should keep this in mind when discussing the renewal of measures such as digital teaching and remote learning. While such actions might be justifiable to ensure the physical health of the students, they may also endanger students' mental health (see Deng et al., 2021; Gao et al., 2020; Lasheras et al., 2020). If campus closures cannot be avoided, educational practitioners may at least want to consider ways to address students' need for genuine connection, which showed an especially detrimental development (see especially Tice et al., 2021, regarding teaching strategies addressing relatedness in digital environments).

Limitations and future research

It is important to bear in mind that the students participating in our study were affected by societal measures to combat the pandemic in a variety of environments. While our measures strictly focused on students' experiences in their academic surroundings, it remains possible that experiences of restricted options to connect with significant others outside of university may have led to generalized feelings of loneliness impacting reflections about relatedness at university. Nevertheless, it seems particularly implausible that the long-term deterioration of relatedness was unconnected to the campus closures altogether given that other areas of social life (e.g. workplaces, bars and restaurants) at least partly reopened over the course of the pandemic. The university campus is a central place for ad-hoc as well as planned social gatherings. Closing it for years has likely confronted students with prolonged episodes of social isolation that are reflected in our findings.

Another limitation is that our comparison sample was collected 6 years before the enforcement of campus closures. Propensity score modelling allowed us to ensure relative similarity between the two studied samples. Additionally, content and curriculum of the study programmes as well as enrolment requirements at the investigated university saw little change between 2013 and 2019. The German higher education sector, furthermore, saw no substantial large-scale reforms that affected structural aspects of the study programmes during the time span. Overall, we therefore consider the implementation of campus closures to be the most drastic change between the cohorts. However, we cannot rule out that some of the developmental patterns that we attribute to the campus closures at least partly result from more general changes in internal factors (such as personal values) during the 6-year period. To further our understanding regarding specific cohort effects and effects of campus closures, it would be interesting to compare our findings on developmental trends with data from future cohorts.

While some researchers have argued that intrinsic motivation may facilitate need satisfaction (e.g. Yang et al., 2018), the theoretical framework of SDT generally suggests that the initial deterioration in intrinsic learning motivation may rather be due to impaired need satisfaction than vice versa (Goldman et al., 2017; Ryan & Deci, 2017; Vansteenkiste & Ryan, 2013). However, our data do not sufficiently allow investigations into this postulate because the time span between the time points is not sufficiently short to allow for a fine-grained picture. Specifically, the strongest deceleration of motivational development took place between the second time point when students had little experience with campus closures and the third time point when students had experienced digital teaching and online learning for 6 months. Intricate mechanisms linking need satisfaction and intrinsic learning motivation during this period cannot be modelled with our data. While our study amends prior cross-sectional research on need satisfaction during the pandemic, we thus see the need for further studies into the causality behind the observed developmental changes.

CONCLUSION

Educational policy around the world has mostly focused on reopening primary and secondary education institutions following the initial implementation of lockdown measures (OECD, 2021b). Neglecting the

higher education sector might have been shortsighted as our findings suggest that prolonged campus closures pose a real threat to the psychological functioning of university students as well. We found that especially undergraduate students' ability to connect with their peers was severely impaired. This is worrisome given the known associations of relatedness with students' well-being (Suhlmann et al., 2018) and their intention to drop out of higher education (Höhne & Zander, 2019). In sum, we consider it of utter importance to acknowledge the impact of campus closures on students' basic psychological need for genuine human connection when discussing future measures to address health crises.

AUTHOR CONTRIBUTIONS

Stefan Janke: Conceptualization; data curation; formal analysis; funding acquisition; project administration; supervision; writing – original draft. **Laura A. S. Messerer:** Data curation; investigation; project administration; resources; writing – review and editing. **Martin Daumiller:** Conceptualization; data curation; formal analysis; methodology; visualization; writing – review and editing.

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CONFLICT OF INTEREST

All authors declare no conflict of interest.

OPEN RESEARCH BADGES



This article has earned an Open Data badge for making publicly available the digitally-shareable data necessary to reproduce the reported results. The data is available at <https://osf.io/wc4v7>.

DATA AVAILABILITY STATEMENT

The data that supports the findings of this study is openly available via the Open Science Framework [Link: <https://osf.io/wc4v7>].

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