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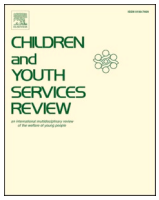

The home environment during the COVID-19 pandemic and changes in learning enjoyment and learning effort: A study of German lower secondary school students

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ABSTRACT

This study investigated changes in learning enjoyment and learning effort, two central yet under-researched aspects of school-related emotion and motivation, before and during the COVID-19 pandemic. It also verified whether selected aspects of the home environment predicted changes in the two aspects. To this end, we used data gathered from 4240 German lower secondary school students surveyed before (Grade 7, 2018/19) and during the COVID-19 pandemic (Grade 8, 2019/20 and Grade 9, 2020/21). The analyses, which involved latent change score models with covariates, revealed a decrease in student learning enjoyment and learning effort between Grades 7 and 9. Moreover, the student-perceived consequences of the pandemic predicted a decrease in both of these constructs, whereas parental ability to provide learning support during distance learning predicted a decrease in learning enjoyment. The strength of this relationship depended on prior student academic achievement. The results highlight the role of environmental factors for the development of learning enjoyment and learning effort.

1. Introduction

The COVID-19 pandemic disrupted school learning environments due to contact restrictions and school closures, necessitating remote teaching and/or asynchronous instruction (Daumiller et al., 2023). These changes posed a challenge not only to schools but also to students and their families, as they had to adapt to the requirements of distance learning. This involved altering everyday schedules and partly modifying the level of parental involvement and assistance for school and academic assignments (Sanrey et al., 2021).

Most research on the impact of school closures and altered learning conditions during the pandemic has centered around students' academic progress. It is widely believed that the changes affected schooling outcomes, with learning losses and lower school achievement as the most important consequences (Betthäuser et al., 2023). However, only a small number of studies have investigated students' school-related emotional and motivational experiences during that period. Emotions and motivation are fundamental for successful learning (Bishop, 2006; Pekrun, 2006) and are positively linked to academic achievement (Camacho-Morles et al., 2021; Carbonaro, 2005). Moreover, the few available studies on school-related emotions and motivation during the pandemic have mainly sought to predict the levels of motivation or feelings related to school (Arslan et al., 2022; Strasser et al., 2023). The pre-pandemic levels of both were measured retrospectively, if at all (Camacho et al., 2021; Hornstra et al., 2022; Tannert & Gröschner, 2021; Zaccoletti et al., 2020), which could introduce biases (see Steinmayr et al., 2022 for an exception).

Although these studies delved into the emotional and motivational aspects of learning, they were primarily cross-sectional. Therefore, they did not capture developmental trends triggered by changes in learning conditions. Additionally, there has been little discussion on the role of the home learning environment, which was the primary location of school learning, particularly throughout school closures. In addition, these studies did not take into account differing student reactions to the changed learning environments depending on ability levels.

Although all families and students experienced the pandemic, its consequences for families, their responses to it, and thus the impact on the family members varied (Vogelbacher & Attig, 2022). Students needed a differing amount of support and guidance from their parents during distance learning, and parents' ability to provide such help and resources at home varied widely between families (Andrew et al., 2020). Moreover, educators and school personnel encountered difficulties with

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remote teaching, lacking appropriate knowledge on the utilization of digital tools for instruction and alternative means of communicating with their students and families to allow successful home-based educational practices. This resulted in poorer school and instructional quality (Helm & Huber, 2023).

Assuming that these changes in learning environments and students' needs during that time could impact learning-related emotions and motivation, this study focused on the development and changes of learning enjoyment and learning effort in secondary school during the pandemic and periods of school closure, two under-researched yet central aspects of school-related emotions and motivation. It drew on longitudinal data from the German National Educational Panel Study (NEPS; Blossfeld & Roßbach, 2019), which allowed us to model changes over time by taking pre-pandemic information into account. First, we modeled the changes in learning enjoyment and learning effort across two measurement occasions, one before and one after the nationwide school closures. Second, we included predictors related to the home environment and students' prior achievement to explain changes in learning-related emotion. Finally, we investigated the interaction effects between aspects of the home environment and prior achievement.

2. Theoretical framework

Individual development is shaped both by proximal and distal processes taking place in the surrounding (learning) environments (Bronfenbrenner & Morris, 2006). Especially during childhood and adolescence, the family, school, and peer environments play an important role in supporting an individual to thrive. An essential aspect for positive (academic) development is ensuring that the surrounding learning environment is tailored to students' needs (Eccles et al., 1993).

The framework proposed by Prime et al. (2020) utilizes the model of surrounding learning environments to present theoretical principles related to how the COVID-19 pandemic posed a potential threat to children and their families. Adverse social factors induced by the pandemic, such as financial insecurity or social distancing, potentially had a negative impact on children's ability to adjust to their surrounding environments. This, in turn, could have influenced their development, well-being as well as behavioral and emotional functioning (Prime et al., 2020). Undoubtedly, the pandemic, its restrictions, and school closures challenged students and their families, resulting in adverse circumstances. In this situation, students' home situation may have explained, at least to some extent, their school-related emotional and behavioral functioning, including positive learning emotions and high motivation. Positive learning emotions and high learning motivation are essential individual requirements for students to successfully master these periods of school closure. Learning enjoyment and learning effort are significant learning-related emotions and motivations which positively predict academic achievement (Camacho-Morles et al., 2021; Carbonaro, 2005). Prior research has indicated a declining trend in emotional and motivational aspects of learning throughout schooling. However, it is important to note that inter-individual differences exist, which suggest that decreases in learning enjoyment and learning effort are not inevitable (Ahmed et al., 2013). Rather, changes in learning enjoyment and effort can be influenced by contextual elements of the learning environment.

2.1. Learning enjoyment

The most commonly studied learning-related emotion is learning enjoyment. It is a positive emotional state that is accompanied by high arousal during learning-related activities (Pekrun, 2006). A higher level of enjoyment in learning is linked to higher academic achievement (Hagenauer & Hascher, 2014). Learning enjoyment plays a crucial role as a component and resource for self-regulated learning, facilitating organization of independent learning (Ahmed et al., 2013).

Characteristics and processes within the learning environment, for instance, classroom practices, play a pivotal role in fostering learning enjoyment. In particular, teacher support serves as a significant source of positive academic emotions, including learning enjoyment (Lei et al., 2018). Teacher neglect of students' needs results in a decline of learning enjoyment (Hagenauer & Hascher, 2010). Research on parental involvement in education, a multidimensional concept, has revealed that it can be positively associated with a child's academic achievement. While parent–child communication had a positive effect on reading competence (Van Voorhis et al., 2013), parental help with homework was found to be negatively associated with student achievement (Hill & Tyson, 2009). Some parents report that they feel unable to assist their child with school- or homework and therefore less capable of becoming involved and supporting their child appropriately (Barge & Loges, 2003).

2.2. Learning effort

Learning-related motivation is closely linked to enjoyment of learning. In performance-based situations, success or avoiding failure requires individuals to make an effort (Pekrun, 2006). Learning effort is the extent to which an individual is willing to work diligently on a task (Pintrich, 2003). It is therefore an indicator of learning motivation (Brophy, 2004). Persistence in the face of challenges is a crucial strategy and highly predictive of long-term success (Moore, Lippman, & Ryberg, 2015). Persistent learning behavior and early investment in schooling have been demonstrated to predict academic achievement several years later (McClelland et al., 2013).

Teachers and parents can substantially facilitate students' learning efforts. Parental involvement is positively associated with children's attitude towards school (Flouri et al., 2002) and children's motivation (Luster et al., 2004). Furthermore, the extent of student effort is correlated with satisfaction related to teacher guidance and the social environment within school (Hopland & Nyhus, 2016). The development of learning effort and perseverance is positively predicted by teachers' classroom management (Domínguez et al., 2010).

2.3. Changes in learning environments during the COVID-19 pandemic

During the pandemic and the related school closures, the students' main learning environment changed significantly. This school closure period was characterized by remote learning, adapted instructions, and partially asynchronous lessons with reduced teacher guidance and support. The importance of the home environment and its conditions, including equipment and parental support, increased accordingly. At the same time, families were affected by the restrictions imposed by policymakers in various ways, depending on their occupational status and educational background (Feinberg et al., 2022). Families lacking support networks and material resources were particularly vulnerable to the crisis and faced significant challenges (Knabe et al., 2023). Overcoming this period of hardship required substantial effort from such families.

Overall, parents were required to assume considerable responsibility for supporting their children's education (Vogelbacher & Attig, 2022). However, they felt they were able to offer only moderate levels of support during school closures, and the extent of this burden varied depending on their children's previous academic performance (Nusser, 2021). Moreover, parents with a higher educational background tended to provide more support (Ribeiro et al., 2021). In addition, children's individual factors, such as their need for support and their prerequisites for learning and motivating themselves, were also relevant explanatory variables for the situation at home and how it was dealt with. Students' ability to learn in a self-regulated way and to motivate themselves may depend on their personal resources (Wolters et al., 1996).

Additionally, parents were an important partner in interactions taking place in the home learning environment. Parents responded to their children's needs, adjusting their involvement – when possible – appropriately. For instance, students exhibiting less autonomous

learning behavior received more assistance from their parents than students studying independently (Ribeiro et al., 2021). Parents also reported greater difficulties in motivating their child to learn when the child's prior achievements were low (Lockl et al., 2021). Low academic performance results in more controlling support rather than structured support (Dumont et al., 2014). This, in turn, impacts learning-related emotions, motivation, and behaviors (Buff et al., 2017).

A student's achievement levels can provide a protective factor that is an important resource for learning. They are also an indicator of a student's ability to adapt to changing learning conditions (Masten & Coatsworth, 1998). Furthermore, as achievement is also associated with higher levels of learning enjoyment and effort (Camacho et al., 2021), it may moderate the impact of changes in (learning) environments on the development of the two aspects. Higher-achieving students often exhibit a greater capacity to adapt to new and varied contexts and situations. Lower pre-pandemic resources in terms of achievement levels may have made students more vulnerable to negative changes resulting from the pandemic (Berger et al., 2021). Students with such academic weaknesses were possibly more dependent on external resources, which were unlikely to be provided by teachers during school closures, thus requiring parental support.

3. Present study

To summarize, this study tracked changes in learning enjoyment and learning effort before and during the pandemic. We captured the development of the two constructs as well as selected characteristics of the learning environment during the COVID-19 pandemic on two measurement occasions. In general, based on prior research, we expected a decline in learning enjoyment (H1) and learning effort (H2). Moreover, we expected good learning conditions at home and high abilities of parents to support their child to predict a lower decline in learning enjoyment (H1.a and H1.b) and effort (H2.a and H2.b). Similarly, we expected high-quality instruction and teacher support, as expressed by satisfaction with school support, to predict a lower decline in learning enjoyment (H1.c) and effort (H2.c). The negative consequences of the pandemic were expected to contribute to a larger decrease in learning enjoyment (H1.d) and effort (H2.d). Higher prior academic achievement was hypothesized to predict a smaller decrease in learning enjoyment (H1.e) and effort (H2.e) as well as to moderate the relationship between the above-mentioned predictors and the decline in enjoyment (H3.a-d) and effort (H4.a-d), with a stronger link in low achievers.

4. Method

4.1. Data and sample

This study used data from the German National Educational Panel Study (NEPS, Blossfeld & Roßbach, 2019; NEPS NEPS Network, 2022). More specifically, we drew the data from the Starting Cohort Kindergarten (NEPS-SC2), which comprises children who started preschool in the school year 2010/2011, when they were approximately four years old, and have been followed since then. Detailed information on the sampling design is available in Aßmann et al. (2019) and on panel selectivity and attrition in Zinn et al. (2020).

In this study, we used data collected in Waves 9 and 10, gathered in the winter semester of Grades 7 and 9. The wave in Grade 8, originally scheduled for spring 2020, was cancelled due to the COVID-19 pandemic. Instead, parents participated in an add-on survey on the pandemic, which we also used in this study. Information on field times is available in Table 1S in the Online Supplement.

A total of 2949 children participated in Wave 1 of NEPS-SC2. In Wave 3, when the children started primary school, 6176 students (an augmentation sample) additionally took part, which increased the total sample size to 9682 participants. Further information on NEPS-SC2 sample is available in Zinn et al. (2020). However, the analytical sample in this study is limited to students attending regular schools with data on learning enjoyment or learning effort in at least one wave, 4240 students in total. Information on the number of observations at each measurement occasion is available in Table 1S in the Online Supplement.

Students in the NEPS-SC2 analytical sample were aged $M = 12$ years 7 months ($SD = 4.2$ months) at the beginning of Wave 9 (Grade 7); 52.08 % of them were female (missing data for 0.12 %); 14.65 % spoke a native tongue other than German (missing data for 9.29 %), and 48.66 % attended an academic track school (missing data for 20.92 %). Although the students came from various social backgrounds, low-SES students were underrepresented in the sample. The parents' position on the International Socio-Economic Index of Occupational Status Index (ISEI-08, Ganzeboom et al., 1992) ranged from 11.74 to 88.96 ($M = 58.45$, $SD = 19.49$, missing data for 3.80 %); 45.05 % of the students had at least one parent with a higher education diploma (missing data for 3.47 %).

4.2. Procedure

The students and their parents participated in computer-assisted telephone interviews. All participants of age and legal guardians of underage participants provided written informed consent before study enrolment. All participants could withdraw from the study at any time. All the analyses are secondary analyses of data published previously. The NEPS study is conducted under the supervision of the German Federal Commissioner for Data Protection and Freedom of Information (BfDI) and in coordination with the German Standing Conference of the Ministers of Education and Cultural Affairs (KMK) and – in the case of surveys at schools – the Educational Ministries of the respective Federal States. All data collection procedures, instruments, and documents were checked by the Data Protection Unit of the Leibniz Institute for Educational Trajectories (LIfBi). The necessary steps were taken to protect participants' confidentiality according to national and international data security regulations.

4.3. Measures

4.3.1. Learning enjoyment and learning effort

Learning enjoyment and learning effort were reported by the students. The items (three in each subscale) were taken from an established German scale on students' emotional and social experiences at school (Rauer & Schuck, 2003) and used a four-point response scale, ranging from *completely disagree* to *completely agree*. The items related to enjoyment referred to liking school and school learning (e.g., "I really enjoy learning at school."). In this study, their reliability equaled 0.876 in Grade 7 and 0.874 in Grade 9 measured with Cronbach's α.

Originally, the scale related to learning effort included four items but we excluded one negatively valenced item due to its low factor loading. The items referred to handling school materials with care, completing school tasks carefully, and making an effort in the face of difficulty (e.g., "I try hard when tasks are difficult."). In this study, Cronbach's α equaled 0.637 in Grade 7 and 0.634 in Grade 9.

4.3.2. Contextual predictors

The conditions for distance learning at home during school closures in Grade 8 were measured retrospectively in Grade 9 with two student-reported items that referred to adequate conditions for learning (e.g., a quiet place) and the availability of technical equipment at home (WLAN, laptops, printers, etc.). Responses were provided with a four-point response scale ranging from *completely sufficient* to *completely insufficient*. The scales were reversed to allow the higher average to indicate better conditions.

The indicator of parental ability to provide learning support during distance learning in Grade 8 consisted of four parent-reported items. These items referred to the parent's self-assessed ability to support the child, his or her knowledge of what the child should work on, and

technical and digital skills (e.g., "I could not help my child with his/her schoolwork."). The items were administered in Grade 8. As they were taken from various parts of the questionnaire, the response scales differed. Therefore, if necessary, the scales were recoded so that a higher value indicated a higher ability to support the child. The confirmatory factor analysis model had a good fit to the data ($\chi^2 = 4.74$, $p = .03$, RMSEA = 0.05, CFI = 0.996, TLI = 0.974, SRMR = 0.013). The reliability (Cronbach's α) equaled 0.64.

Satisfaction with school support of distance learning in Grade 8 was measured in Grade 8 with four parent-reported items. These items referred to how well parents felt supported and informed by the school during distance learning, how happy they were with school-provided learning materials, and how well they assessed the technical and digital skills of their child's teachers (e.g., "How well did you feel supported by your school in this situation during this time?"). The items were taken from different parts of the questionnaire and therefore had different response scales. The confirmatory factor analysis model had a good fit to the data, $\chi^2 = 1.3$, $p = .27$, RMSEA = 0.012, CFI = 1.000, TLI = 0.999, SRMR = 0.004. Cronbach's α equaled 0.72.

The direct consequences of the pandemic were measured with five student-reported items that referred to the extent the student felt affected by various pandemic-inflicted problems, for instance, family conflicts, loneliness, or a lower standard of living. The items referred to the period from March 2020 (Grade 8) until the measurement occasion of the study in Grade 9 and had a five-point response scale ranging from *not at all* to *very strongly*. The confirmatory factor analysis model had a good fit to the data, $\chi^2 = 41.2$, $p < .001$, RMSEA = 0.045, CFI = 0.974, TLI = 0.949, SRMR = 0.021. The reliability (Cronbach's α) equaled 0.63.

4.3.3. Prior academic achievement

Student academic achievement was used as a proxy for a student's personal learning-related resources. It was measured in Grade 7 with three achievement tests (math, reading, science) which were designed for the NEPS (see Kähler, 2020; Kock et al., 2021; Scharl et al., 2021). Weighted least squares estimates (WLE), which were available in the dataset, served as indicators of achievement in each test. The confirmatory factor analysis model showed a good fit to the data, $\chi^2 = 3.13$, $p = .08$, RMSEA = 0.024, CFI = 0.998, TLI = 0.995, SRMR = 0.014. Cronbach's α equaled 0.827.

4.3.4. Controlled variables

Students' migration background was operationalized as a student specification of speaking a native tongue other than German (scored as 1) as opposed to German only (scored as 0). Socio-economic background was measured with ISEI-08, an index based on detailed questions on parental employment. The index captures the attributes of occupations which convert parents' education into income (Ganzeboom et al., 1992); it was available in the dataset. We used the most recent information available in Wave 9. If it was available for both parents, the higher value was chosen. With respect to gender, 1 denoted female, whereas 0 denoted male students. The attendance of an academic track school in Grade 7 was scored as 1; 0 denoted attendance of a non-academic track school in Grade 7.

4.4. Statistical analyses

In the first step, we ran a series of confirmatory factor analyses to test the longitudinal measurement invariance of the scales for learning enjoyment and learning effort. We started from configural invariance, with parameters estimated freely across the measurement occasions. Next, we incrementally constrained the factor loadings (metric invariance) and intercepts (scalar invariance) to equality and tested whether imposing constraints worsened the model fit. Comparing the means of latent factors requires at least partial scalar invariance. For details on longitudinal invariance testing, see for instance Wickrama et al. (2022).

In the second step, we estimated latent change score models (LCS) for learning enjoyment and learning effort separately (Models 1A and 1B, respectively). The models allowed us to investigate changes in each variable over time, which was necessary for the correct interpretation of the models estimated later. The change score variables (denoted by Δ) represent interindividual differences in intraindividual change between two consecutive measurement occasions (e.g., Geiser, 2021). A positive change score indicates an average increase, whereas a negative change score indicates an average decrease. The models included the parameter constraints that were tested and selected as final in the analyses of measurement invariance.

The repeated administrations of the same item were allowed to covary. As both variables were measured two times, each model included one change score variable. Fig. 1 presents a diagram for an LCS with two-wave data.

Next, we proceeded to test hypotheses for predictors of change. To this end, we followed the procedure for testing latent interactions suggested by Cheung et al. (2021), adjusting it to the specificity of LCS. We started by adding all latent predictors to the previously estimated LCS to verify whether the measurement part had a good fit to the data (Models 2A and 2B). The latent predictors were allowed to correlate with each other, with the baseline level, and with change score variables. Next, we estimated LCS with controlled variables only to verify how much variance of the change score variable the controlled variables explained (Models 3A and 3B). In the next step, we added the main effects of contextual factors on the latent change score (Models 4A and 4B). This provided baseline fit indices to be used for evaluating the models with added latent interactions, which were estimated next (Models 5A and 5B). Because interactions between latent variables are very heavy computationally, all models (including LCS) were estimated for enjoyment (A) and effort (B) separately.

All models used a robust maximum likelihood estimator (MLR). The scales of the latent predictors were identified by fixing the first factor loading to unity and its intercept to zero. The observed continuous predictors were centered. There was no need to control for the clustering of students in schools, because the students had already transitioned to lower secondary school and were followed individually. We assumed that a good fit was indicated if the values for the comparative fit index (CFI) and Tucker–Lewis index (TLI) were not lower than 0.95, the standardized root mean squared residual (RMSEA) not higher than 0.06, and the standardized root mean squared residual (SRMR) not higher than 0.08 (Hu & Bentler, 1999). As the indices are not available for models with latent interaction terms, we assessed the fit of these models by comparing them to analogous models without interaction terms using the Satorra-Bentler Scaled χ^2 Difference Test (e.g., Cheung et al., 2021).

With respect to measurement invariance, we followed the recommendations made by Chen (2007) and assumed that a decrease in CFI $\geq$ 0.010 supplemented by an increase in RMSEA $\geq$ 0.015 or an increase in SRMR $\geq$ 0.030 indicated metric non-invariance. In turn, a decrease in CFI $\geq$ 0.010 supplemented by an increase in RMSEA $\geq$ 0.015 or an increase in SRMR $\geq$ 0.01 indicated scalar non-invariance.

The analyses were run in Mplus 8.8, whereas the data preparation and basic analyses (e.g., scale reliabilities) were carried out in Stata 16.1. The analysis code for the LCS is available in the Online Supplement. The study was not pre-registered.

4.5. Missing data

In general, the missingness in NEPS-SC2 was sizable. A total of 70.3 % of the students provided data on learning enjoyment on both measurement occasions, and 70.5 % provided complete data on learning effort. With respect to the predictors, the percentage of students without data on a given variable ranged between 11.0 % (academic achievement in W9) to 64.3 % for parent-reported variables (Grade 8). Table 1S in the Online Supplement contains further information on the number of participants in each wave, whereas Table 2S provides further information on the completeness of the data.

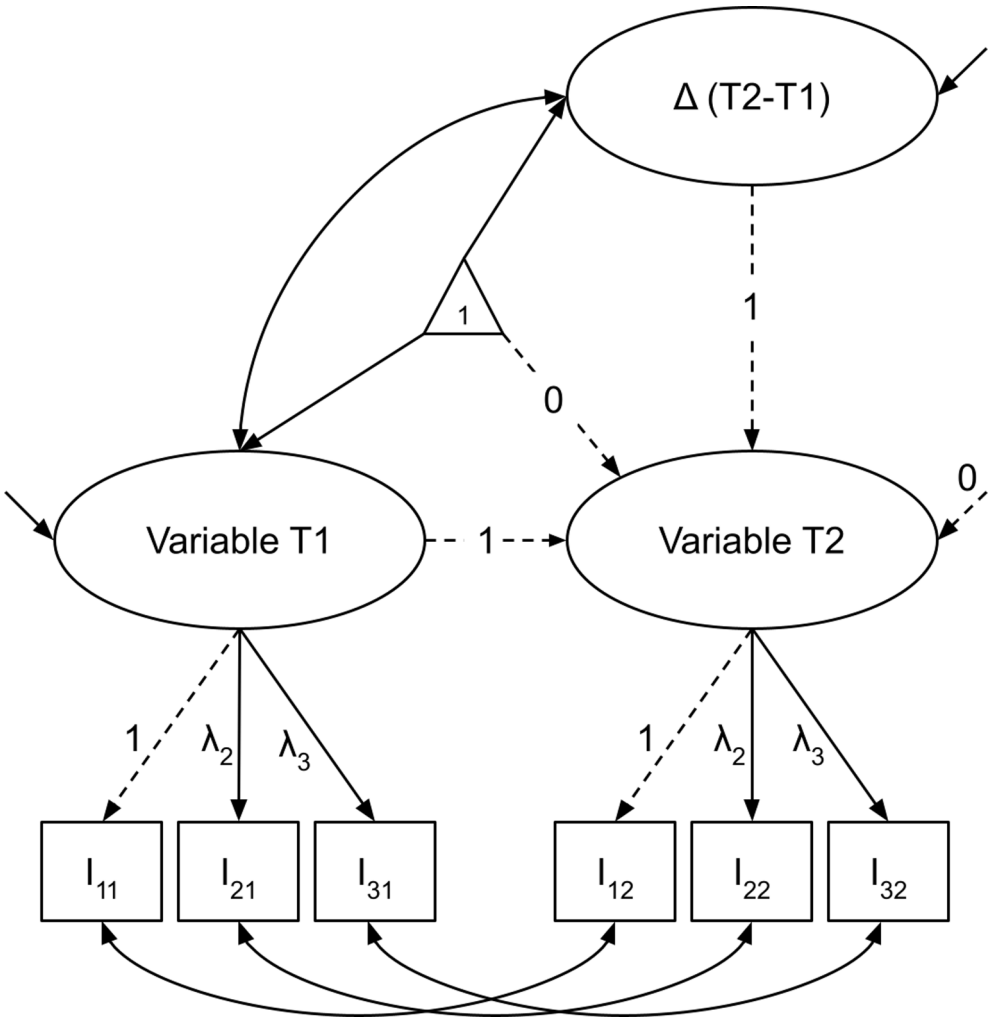

Fig. 1. A path diagram for a two-wave latent change score model.

Missing data were handled using full information maximum likelihood estimation (FIML) because it allowed us to use the information on all available cases. This method is recommended for longitudinal studies (Jeličić et al., 2009) and yields unbiased estimates even when the share of missing data is significant, as long as the missing-at-random assumption (MAR) holds. (Enders, 2010). Under MAR, missingness is allowed to be a function of the variables in the model, but not the variable with missing values. Hence, repeated measurements decrease the likelihood of MAR being violated, because missing values are allowed to depend on another measurement of the same variable (Marsh et al., 2022). To further increase the probability that the missing-at-random assumption held, the models included several missing data correlates either as additional auxiliary variables (Muthén et al., 2016) or as part of the model (Snijders & Bosker, 2012). These correlates were: academic achievement, socio-economic status, migration background, gender, and school track. The variables were selected based on preliminary analyses of missing data correlates (not presented here).

4.6. Sensitivity analyses

The use of LCS is not recommended when the predictors of change depend on the baseline level of the outcome (Lüdtke & Robitzsch, 2023). In this study, the predictors correlated weakly (between -0.06 and 0.14) with learning enjoyment and learning effort in Grade 7. To verify whether this weak correlation could affect the results, we re-estimated Models 4, 5, and 6 (A and B) while controlling for enjoyment and effort in Grade 7. The details are described in the Online Supplement.

5. Results

Descriptive statistics and correlations between the variables in the study are available in Table 3S in the Online Supplement. Confirmatory factor analyses revealed that the scale measuring learning enjoyment was scalarly invariant. The learning effort scale was metrically invariant but it was possible to establish partial scalar invariance by freeing the intercepts of one item. Table 4S in the Online Supplement presents detailed information on invariance testing.

5.1. Changes in learning enjoyment and learning effort

The LCS that were estimated to investigate changes in learning enjoyment (Model 1A) and learning effort (Model 1B) between Grades 7 and 9 had a good fit to the data (see Table 1). They revealed a decrease in both student characteristics, which was in line with our expectations (H1 and H2). Learning enjoyment decreased by 0.20 *SD*¸ whereas learning effort decreased by 0.06 *SD*. However, the variances for the change score variables were statistically significant, showing interindividual differences in intraindividual change. Their size indicated that, although the average trends were negative, the level of learning enjoyment and learning effort actually increased in some students. The initial levels of enjoyment and effort correlated negatively with the respective changes, indicating that seventh graders who enjoyed learning more and

Table 1
Fit of the tested models.

Model	χ^2	*df*	*p*	RMSEA	CFI	TLI	SRMR
Learning enjoyment							
1A: LCS	51.8	9	< 0.001	0.033	0.996	0.993	0.021
2A: Measurement model	607.7	193	< 0.001	0.023	0.979	0.974	0.038
3A: LCS + controlled var	128.3	40	< 0.001	0.031	0.991	0.986	0.018
4A: LCS + controlled var + main effects	1097.3	273	< 0.001	0.027	0.960	0.951	0.038
Learning effort							
1B: LCS	52.2	9	< 0.001	0.034	0.991	0.984	0.019
2B: Measurement model	708.1	193	< 0.001	0.025	0.959	0.951	0.042
3B: LCS + controlled var	228.6	25	< 0.001	0.044	0.962	0.940	0.028
4B: LCS + controlled var + main effects	1065.0	270	< 0.001	0.026	0.945	0.930	0.040

Note. N = 4240. LCS = latent change score model; Enjoyment = learning enjoyment; Effort = learning effort; RMSEA = root mean square error of approximation; CFI = comparative fit index; TLI = Tucker-Lewis Index; SRMR = standardized root mean squared residual.

put more effort into learning decreased more in the two attributes over time. Detailed results are available in Table 2.

5.2. Predictors of change

Next, we tested hypotheses related to the predictors. Table 1 presents the fit of the tested models. With respect to learning effort, the measurement model for latent variables (2B) had a good fit to the data and showed good properties for the included scales (i.e., satisfactory factor loadings, low latent inter-correlations, etc.; details are not presented here). Therefore, we estimated the model with controlled variables only (3B), which also fitted the data well. The controlled variables explained 0.90 % of the change in learning effort between Grades 7 and 9. Adding the predictors of change as main effects (Model 4B) increased R^2 to 2.20 %. We selected this model as final because its fit was not worse than the fit of Model 5B with latent interactions between contextual factors and prior achievement, $\Delta\chi^2$ (4240, 3) = 0.01, p =.992. It also meant that hypotheses H4.a-d were not confirmed. Detailed results of Model 5B are available in Table 5S in the Online Supplement. The final model (4B) included only one significant main effect. Stronger direct consequences of the pandemic were associated with a larger decrease in learning effort between Grades 7 and 9 (β = -0.09, supporting H2.d). Details are presented in Table 3.

With respect to learning enjoyment, the measurement model for latent variables (2A) had a good fit to the data, and the included scales showed good properties (satisfactory factor loadings, low latent inter-correlations, etc.; details are not presented here). Therefore, we estimated the model with controlled variables only (3A), which also fitted the data well. The controlled variables explained 0.90 % of the change in learning enjoyment between Grades 7 and 9. After adding the predictors of change as main effects (Model 4A), R^2 increased to 2.20 %. In the next step, we added latent interactions between academic achievement and contextual predictors (Model 5A). In the model, which is presented in detail in Table 5S in the Online Supplement, only one interaction was statistically significant. Therefore, we excluded all non-significant interactions (Model 6A), which allowed us to interpret the coefficients for all remaining predictors of change as main effects instead of as simple effects. As Model 4A (with no interactions) had a significantly poorer fit than Model 6A, $\Delta\chi^2$ (4240, 1) = 5.95, p =.015, we selected Model 6A as final. In the model, stronger direct consequences of the pandemic were associated with a larger decrease in learning enjoyment between Grades 7 and 9 (β = -0.13, H1.d supported). Moreover, there was a significant interaction between parental ability to support the child during distance learning and the child's prior ability. The interaction explained an additional 1.1 % of variance of change in enjoyment (Model 6A's R^2 = 3.3 %) in comparison to the model without the interaction (4A). The Cohen's f^2 for the interaction (e.g., Cheung et al., 2021), which is an effect size that represents the share of residual variance in the dependent variable accounted for by the interaction (over and above the main effects and controlled variables), equaled 0.011. To interpret the interaction, we calculated simple slopes at achievement, 2, 1.5, 1, and 0.5 *SD* above and below the mean and bootstrapped their confidence intervals based on 1000 bootstrap draws. Next, we plotted them using the Johnson-Neyman technique (Fig. 2).

The analysis of Fig. 2 indicated that there was no relationship between parental ability to support the child during school closures and change in enjoyment in students with low, medium, and high prior achievement (1 *SD* above the mean). However, the relationship was positive in students who were more than 1.5 *SD* above the mean (see Table 6S in the Online Supplement for details). Although we expected the interaction, H3.b was not supported because its pattern was different than hypothesized.

Table 2
The results of latent change score models for learning enjoyment and learning effort: latent means, variances, and correlations.

Coefficient	Learning enjoyment			Learning effort		
	Mean	*Var*	G7	*Mean*	*Var*	G7
G7	2.876	0.492		3.220	0.234	
	(0.013)	(0.015)		(0.011)	(0.011)	
Δ 1 (G9-G7)	0.133	0.423	-0.459	0.023	0.156	-0.405
	(0.013)	(0.017)	(0.015)	(0.009)	(0.009)	(0.023)

Note. N = 4240. G = Grade; Δ = change score variable. Standard errors are in parentheses. All coefficients are statistically significant.

5.3. Sensitivity analyses

For learning enjoyment, the results of the sensitivity analyses were in line with the main findings, both with respect to statistical significance and the size of regression coefficients. For learning effort, the sole discrepancy involved the regression coefficient for parental ability to support the child during school closures. This coefficient was statistically significant (albeit small in magnitude) in the sensitivity analyses but not in the main analyses. Consequently, we will not interpret this finding in the discussion. Overall, the sensitivity analyses largely corroborated the main findings. For detailed results, please refer to Tables 8S, 9S, and 10S in the Online Supplement.

6. Discussion

This study aimed at verifying whether school and home conditions for learning during the COVID-19 pandemic and during pandemic-related school closures were associated with changes in learning enjoyment and learning effort in lower secondary school students. It revealed that learning enjoyment and effort decreased between Grades 7 and 9 on average. Student-perceived consequences of the pandemic predicted a decrease in both of the aspects of student functioning. Moreover, parental ability to provide learning support during distance learning predicted a change in learning enjoyment, but only among high achievers.

Table 3
The results of regressing change on predictors.

Variable	Change in learning enjoyment (Model 6A)				Change in learning effort (Model 4B)		
	Est. (SE) [a]	*p*	β	Bootstrapped 95 % CI	Est. (SE)	*p*	β
Conditions at home	0.027 (0.033)	0.406	0.021	[-0.095, 0.035]	0.001 (0.024)	0.981	0.001
Parental ability to support	0.020 (0.045)	0.653	0.020	[-0.105, 0.070]	0.034 (0.032)	0.285	0.056
Satisfaction with school	0.021 (0.048)	0.670	0.016	[-0.112, 0.085]	0.016 (0.038)	0.663	0.021
Consequences	0.198 (0.048)	< 0.001	0.128	[-0.296, 0.100]	0.087 (0.034)	0.011	0.093
Achievement in G7	0.011 (0.020)	0.601	0.016	[-0.054, 0.032]	0.014 (0.015)	0.328	0.033
Ach x Conditions							
Ach x Parental	0.100 (0.040)	0.013	0.099	[0.015, 0.179]			
Ach x School							
Ach x Consequences							
R^2	0.033 (0.012)	0.005			0.022 (0.009)	0.018	

Note. N = 4240. Conditions at home = conditions for distance learning at home; Parental support = parental ability to support the child in learning during distance learning; Satisfaction with school = satisfaction with school support during distance learning; Consequences = consequences of the pandemic; Achievement G7 = academic achievement in Grade 7, Bootstrapped 95 % CI = bias-corrected bootstrap confidence interval (the ML estimator was used). The models controlled for gender, migration background, SES, school track.

[a] LL = -95704.4, correction factor for MLR = 1.1152, number of parameters = 133, AIC = 191674.880, BIC = 192519.739, Adj. BIC = 192097.120.

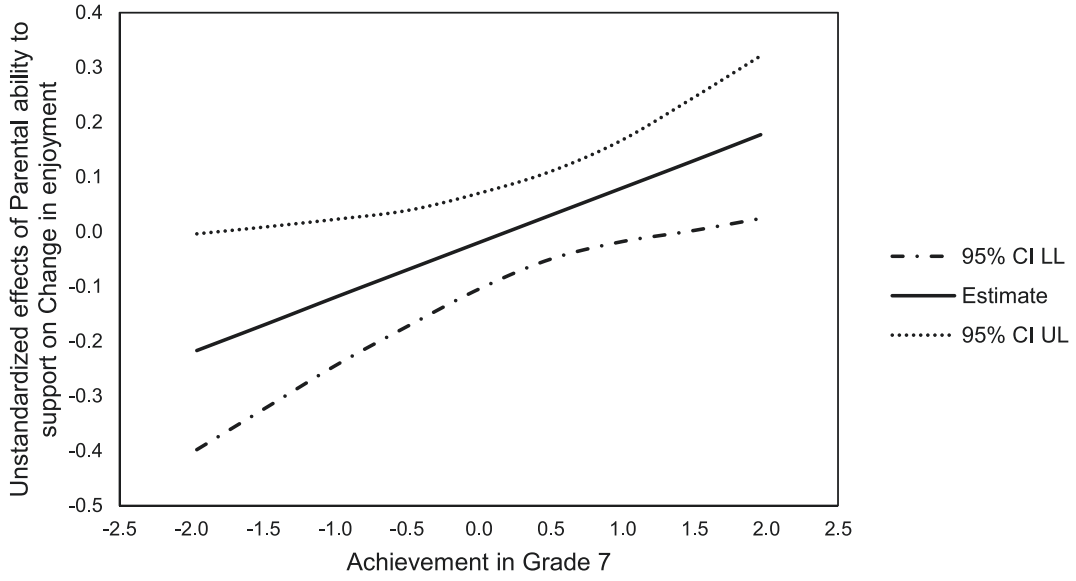

Fig. 2. Unstandardized effects of parental ability to provide learning support during distance learning on change in learning enjoyment.

6.1. *Changes in learning enjoyment and learning effort*

As expected, learning enjoyment and learning effort decreased between Grades 7 and 9, which provides evidence of a decline in two further student attributes during the pandemic. Other research has reported a decline in other aspects of student functioning during the period, for instance, motivation to learn, well-being, or life satisfaction (e.g., Camacho et al., 2021; Hornstra et al., 2022; Steinmayr et al., 2022; Zaccoletti et al., 2020). There is therefore indication of a broader downward trend across multiple student attributes during the pandemic.

However, research on changes in domain-specific learning enjoyment (e.g., Ahmed et al., 2013; Hagenauer & Hascher, 2010) and homework effort (Trautwein et al., 2006) conducted before the pandemic also revealed a decline in these attributes. As a consequence, the decreases observed in this study cannot be interpreted solely as a result of the pandemic. As reported in previous studies, they may represent developmental trends occurring irrespective of the pandemic. In other words, the decline was most probably a result of both developmental trends and the pandemic. However, our data do not allow us to disentangle the effects. This interpretation stands in contrast to other studies that observed declines in student functioning during the pandemic and interpreted them as caused by it (e.g., Steinmayr et al., 2022; Zaccoletti et al., 2020). However, as their authors failed to present evidence that the decreases were not due to long-term trajectories of change, we do not believe that their causal interpretations were warranted. On the other hand, the current study documents changes in learning enjoyment and learning effort from before to during the pandemic and examines their pandemic-related predictors. Moreover, in contrast to other studies on student functioning (e.g., Camacho et al., 2021; Hornstra et al., 2022; Zaccoletti et al., 2020), it uses repeated measurements of learning enjoyment and learning effort before and during the pandemic, instead of measuring the pre-pandemic levels retrospectively.

Learning enjoyment decreased relatively more than learning effort (0.20 *SD* versus 0.06 *SD*). The exact causes of this difference are not clear. Possibly, effort put into learning is at least partially controllable by the individual or by the environment (e.g., parents). As it is valued in the context of learning (e.g., Brookhart, 1997; Heyder, 2019), either students or their parents may take steps to maintain it. However, a similar level of control does not apply to emotional experiences (including learning enjoyment) in learning situations, making them potentially more prone to change.

However, despite the overall decrease in learning enjoyment and effort, the variability of intraindividual change was substantial, which

indicated that some students experienced an increase in learning enjoyment and learning effort. This, in turn, suggests that a decline is not inevitable. As the stage-environment fit (Eccles et al., 1993) and self-determination theory suggest (Ryan & Deci, 2020), a decline may be avoidable if the learning environment matches a student's needs.

6.2. Predictors of change

The student-perceived consequences of the pandemic predicted a decrease in learning enjoyment and learning effort, irrespective of prior academic achievement and beyond the effect of SES (as it was controlled for). This confirms that the pandemic impacted the students and their school functioning differently. Although this result may seem trivial, this differential impact has rarely been shown empirically. Past studies have mostly revealed that various disadvantaged groups were worse off with respect to, for instance, mental health, academic achievement, or well-being, taking it as a proof that those groups experienced more severe consequences of the pandemic (see e.g., Daumiller et al., 2023 for a review). This study, on the other hand, directly tested the association between such (perceived) consequences and changes in student outcomes.

Although we investigated a direct link between the consequences of the pandemic and student outcomes, we cannot exclude that they might be indirectly associated. The items were designed to reflect overall living conditions and, therefore, probably represented stressors to which not only students but also parents were exposed. As a result, these consequences may have also affected students indirectly via parental behavior (e.g., lowered availability or responsiveness to needs). Both theory (e.g., Masarik & Conger, 2017) and research (e.g., Jackson & Choi, 2018; Mak et al., 2020; Valienteet al., 2007; Riem et al., 2021) have indicated that harsh parenting, including lower responsiveness, mediates between hardship, parenting stress, or work-related stress and student outcomes.

The analysis also revealed that parental ability to provide the child with learning assistance during distance learning predicted a smaller decline in enjoyment, but only among high achievers, contrary to our expectations. It suggests that parental ability to support the child during distance learning did not play a (compensatory) role for children with low academic resources (operationalized as academic achievement). Instead, both high parental ability to support and high academic resources were necessary conditions for improved learning enjoyment.

Although the study did not confirm the hypotheses related to the role of distance learning conditions at home and parental satisfaction with school support for distance learning, it does not necessarily mean that these aspects of learning environments during school closures did not shape changes in student learning enjoyment and learning effort. The period between the first and second measurement occasion was long in comparison to the period of school closures to which the two measures refer. Students might have "recovered" to some extent with respect to their enjoyment and effort by the second measurement occasion, which could attenuate the association (in the case of parental ability to provide support) or make it disappear (in the case of the two remaining factors).

On the other hand, the lack of link between conditions for distance learning at home and both outcomes is in line with the results reported by Tannert and Gröschner (2021). They did not find a relationship between the technical aspects of digital lessons (e.g., the ease of using online tools) and the level of learning enjoyment. This points to the possibility that technical aspects might not be as important as initially thought, at least with respect to some aspects of emotion and motivation (and in countries with wide access to digital technology). It also suggests that the widely voiced worries that technical aspects of distance learning or technological inequality could affect school learning and functioning may not apply.

6.3. Limitations and future research directions

In the interpretation of the study's results, several limitations should be taken into account. First, the rates of missing data, especially for parent-reported variables, were considerable. Although we used a state-of-the-art method for dealing with missing data and included missing data correlates in the models, we cannot assure that the results are not biased. High rates of missing data, although undesirable, are not uncommon in large-scale longitudinal studies (see e.g., Jeličić et al., 2009). The decreased availability of parents at the beginning of the pandemic also contributed to the high rates of missing data. Nevertheless, future studies should undertake measures to reduce missing data rates.

Second, two variables in the study (conditions for distance learning at home and direct consequences of the pandemic) were measured retrospectively, which could diminish their validity. Retrospective measures are prone to memory error and social desirability, but past research has revealed their usefulness, especially when they refer to factual information (e.g., Gilger, 1992; Henry et al., 1994). Moreover, due to the manifold disruptions caused by the COVID-19 pandemic, collecting non-retrospective data was impossible.

Finally, despite some significant relationships, the overall effects of the contextual factors were small, as the predictors explained up to 3.3 % of the changes. Low effects were not unexpected on account of the period between the two measurement occasions. Moreover, research conducted before the pandemic also revealed a decline in student motivational and behavioral functioning (e.g., Ahmed et al., 2013; Trautwein et al., 2006). This suggests that factors not related to COVID-19 played a role in the observed decline in learning enjoyment and learning effort. Although the opportunity to collect more comprehensive data has passed, future research could focus on investigating links between the characteristics of learning environments and student school-related emotion and motivation longitudinally. Moreover, studies could consider student interaction with other actors in the learning environment and investigate how this interaction shapes the environment. Research on the dynamic interplay between students' functioning and their learning environments is still in its infancy.

6.4. Implications and conclusion

The results suggest that prolonged hardship, represented in this study by perceived consequences of the pandemic, is negatively related to learning-related motivation and emotion, even if such hardship is not related to school. As motivation and emotion are linked with academic achievement (e.g., Bishop, 2006; Camacho-Morles et al., 2021), this may put affected students on a less advantageous path in the future. Although unable to change the conditions in which students live, schools could implement strategies targeting students showing a decline in learning-related motivation and emotion, or more broadly, declining school functioning in order to counteract this phenomenon. In periods of distance learning, such interventions could focus more on interpersonal relationships, for instance, teacher support (Camacho et al., 2021), or on creating conditions that satisfy students' needs for competence, relatedness, and autonomy in new circumstances (Hornstra et al., 2022). In contrast, the results suggest that improving the conditions for distance learning at home (beyond ensuring access) may not be promising, at least with respect to emotion and motivation.

Moreover, in this study, prolonged hardship was not directly related to school, which implies that the decreases could also be indirectly addressed in broader programs or policies that aim at relieving such hardship, especially in the most affected groups. Additionally, it may be reasonable for research on the effectiveness of such programs and policies to focus on student school-related emotion and motivation.

Overall, the study evidences a decline in selected aspects of school-related emotion and motivation, that is, learning enjoyment and learning effort, during the pandemic. It also sheds light on the predictors of the decline in the home environment. As such, it contributes to knowledge on factors that shape student learning enjoyment and learning effort in times of crisis.

CRediT authorship contribution statement

Anna Hawrot: Conceptualization, Methodology, Data curation, Formal analysis, Visualization, Writing – original draft, Writing – review & editing. **Lena Nusser:** Conceptualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that supports the findings of this study is available from the Leibniz Institute for Educational Trajectories (https://www.neps-data.de/Data-Center/Data-Access).

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.childyouth.2024.107481.

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