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A longitudinal study on the impact of student-teacher and student-peer relationships on academic performance: the mediating effects of study effort and engagement

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ABSTRACT

Despite the recognised importance of student-teacher and student-peer relationships as well as study effort and engagement in predicting academic performance, the interplay between these predictors has received limited attention in higher education research. Building on Study Demands-Resources theories, this longitudinal study explores the favourable impact of student-teacher and student-peer relationships on academic performance (GPA), mediated by study effort and engagement. In total, 613 undergraduate students (68% female; mean age 20 years) from all 13 Dutch public universities completed two online surveys with a 3.5-month interval. Student-teacher and student-peer relationships, study effort, and study engagement were measured at two time points (t1 and t2), while GPA was only measured at t2. Correlation and path analyses revealed that better relationships with both teachers and peers were longitudinally associated with a higher GPA, mediated by more study effort and engagement. This study contributes to the literature by employing longitudinal data, offering stronger causal evidence for processes underlying academic performance. It underscores the importance of fostering positive relationships with both teachers and peers to improve student performance. The findings suggest that educational institutions should implement strategies to strengthen these relationships, thereby enhancing study effort and engagement, ultimately leading to improved academic performance.


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Introduction

The relationships between students and their teachers and between students and their peers have been proven important for how well students perform in their studies (Cotten and Wilson 2006; García-Moya et al. 2019; Hagenauer and Volet 2014; Upadaya and Salmela-Aro 2013). Students who experience a positive relationship with their teachers, i.e., who perceive that teachers acknowledge their efforts and emotions and interact with them in a positive pedagogical manner, feel more at home at their higher education institution and perform better on cognitive tasks (Kim and Lundberg 2016; Meeuwisse, Severiens, and Born 2010). In addition, contact with peers about both personal and course-related matters stimulates academic performance (Brouwer et al. 2016; Hommes et al. 2012; Stadtfeld et al. 2019; Tomás-Miquel, Expósito-Langa, and Nicolau-Juliá 2016; Wilcox, Winn, and Fyvie-Gauld 2005).

While the influence of supportive relationships with teachers and peers is well-known, prior research has seldomly examined how these relationships affect two key psychological processes in learning, namely study effort (i.e., working hard and invest time) and engagement (i.e. experiencing vigour, absorption, and dedication when studying) (Richardson, Abraham, and Bond 2012; Salanova et al. 2010; Schaufeli et al. 2002; Schneider and Preckel 2017; Upadaya and Salmela-Aro 2013). This gap in the literature is striking because effort and engagement are two aspects that many university teachers try to stimulate through their interaction with students and by facilitating peer interaction in and outside of class through collaborative assignments, to ultimately enhance students' academic success. Moreover, existing studies on the longitudinal dynamics of the associations between relationships, effort and engagement is scarce (cf. Upadaya and Salmela-Aro 2015), while longitudinal data offers stronger causal evidence for processes underlying performance. This study seeks to address these gaps by investigating the longitudinal associations between student-teacher and student-peer relationships, study effort, study engagement, and academic performance.

Based on the motivational process of Study Demands-Resources theories (Bakker and Mostert 2024; Lesener et al. 2020; Salmela-Aro, Tang, and Upadaya 2022), this research posits that positive student-teacher and student-peer relationships may act as crucial resources that promote study effort and study engagement. These, in turn, are expected to facilitate academic performance, thereby mediating the effect of student-teacher and student-peer relationships on academic performance (see Figure 1). By examining

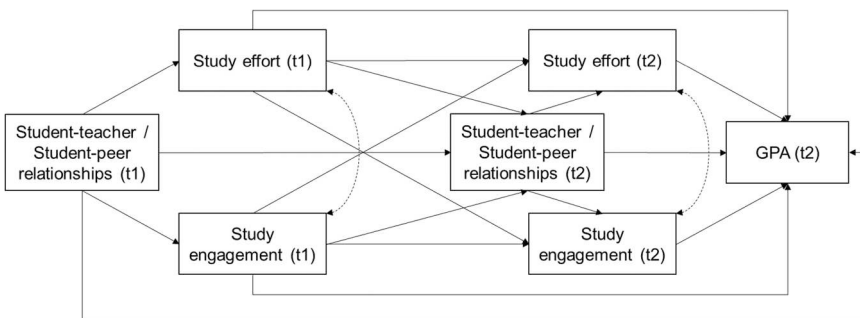


Figure 1. Graphical representation of the model to be tested.

these associations over time, this study offers a more comprehensive understanding of how higher education institutions could improve students' performance in higher education through targeted relationship-building interventions.

Positive relationships as predictors of academic performance

The role of positive, warm, supportive relationships in academic performance has been extensively studied in primary and secondary education (Roorda et al. 2017), but less in higher education (Hagenauer and Volet 2014). In higher education, students have less frequent contact with the same teacher(s), and student cohorts vary across courses. In addition, undergraduate students are expected to regulate their learning more independently, which creates a somewhat different role for the teachers. Rather than acting as direct instructors, university teachers facilitate and coach the learning process, provide academic support, and encourage independent learning (Hagenauer, Muehlbacher, and Ivanova 2023). Despite these differences, the importance of supportive student-teacher relationships and student-peer relationships for academic performance persists.

Earlier research shows that undergraduate students perform better on courses and in their studies in general when they perceive their teachers to make authentic contact, are easily reached for questions or help, and can make students enthusiastic about the course content and their studies (Ma and Wei 2022; Schneider and Preckel 2017). Additionally, studies increasingly highlight the importance of student-peer relationships in undergraduate students' learning and academic performance. For example, discussing study-related matters with peers has a positive effect on study performance (Smith and Peterson 2007; Tomás-Miquel, Expósito-Langa, and Nicolau-Juliá 2016). Other studies indicate that peers frequently serve as a source of academic support (Brouwer et al. 2018; Lomi et al. 2011) and that both friendship-like relationships and study-related relationships with peers promote students' performance (Brouwer et al. 2016; Stadtfeld et al. 2019).

Study effort and study engagement as predictors of academic performance

Reviews (Richardson, Abraham, and Bond 2012; Schneider and Preckel 2017) and other studies (Salanova et al. 2010; Schaufeli et al. 2002; Upadyaya and Salmela-Aro 2013) show that study effort and study engagement are central determinants of academic success.

Study effort can be theoretically linked with the broader perspective on student engagement (Fredricks, Blumenfeld, and Paris 2004; Salmela-Aro, Tang, and Upadyaya 2022) which distinguishes three components of engagement namely, behavioural, emotional, and cognitive engagement. Other research, however, defines study effort independently as an important aspect in students' learning (Pintrich 2004; Robbins et al. 2006). In this study, study effort is defined as a behavioural aspect of students' learning and refers to the extent to which students are willing to work hard, pay attention, and persist in the face of challenging academic tasks (Pintrich 2004; Robbins et al. 2006; van Herpen et al. 2017). Several studies have shown that study effort positively predicts students' performance such as grade point average (GPA) (Kassarnig et al. 2017; Kryshko et al. 2020; Martin, Spenner, and Mustillo 2017; Meeuwisse, Born, and Severiens 2011; Pu, Yan, and Zhang 2020).

Following recent research based on Study Demands-Resources theories (Bakker and Mostert 2024; Lesener et al. 2020; Salmela-Aro, Tang, and Upadyaya 2022; Salmela-Aro and Read 2017), study engagement is defined as a positive study-related cognitive–affective state of mind comprising vigour, dedication, and absorption (Schaufeli et al. 2002). Vigour is characterised by high levels of energy and mental resilience while studying and a willingness to invest in one’s work. Dedication refers to a sense of significance, enthusiasm, inspiration, pride, and challenge. Finally, absorption involves being happily engrossed in one’s study-related work whereby time passes quickly. Study engagement is an important precursor of academic performance. Students who feel committed to learning and working for their studies and who feel energetic during learning activities, achieve better results in their studies than students who feel less engaged (Ayala and Manzano 2018; Loscalzo and Giannini 2019; Martínez et al. 2019; Salanova et al. 2010; Schaufeli et al. 2002; Virgă, Pattusamy, and Kumar 2022; Vollmann, Scheepers, and Hilverda 2024).

Positive relationships as predictor of study effort and study engagement

Study Demands-Resources theories (Bakker and Mostert 2024; Lesener et al. 2020; Salmela-Aro, Tang, and Upadyaya 2022) regard positive relationships with teachers and peers as important study-related resources that positively influence students’ cognitive–affective and behavioural aspects like study effort and study engagement (Jacquemart, De Clercq, and Galand 2024; Kahu and Nelson 2018; Karabchuk and Roshchina 2023). Students find it important that they can rely on their teachers (trustworthiness), that teachers care about their well-being, are accessible and responsive when needed in their studies (Snijders et al. 2021). Moreover, teachers who endorse, recognise, and value their students (i.e., teacher confirmation) stimulate students’ study effort (Campbell et al. 2009), and students who have better contact with peers show more effort for their studies (Kassarnig et al. 2017). In addition, a growing body of research shows that students who experience positive relationships with teachers and peers feel more engaged with their studies (Descals-Tomás et al. 2021; Farr-Wharton et al. 2018; Gutiérrez et al. 2019; Salanova et al. 2010; Sun et al. 2022; Versteeg, Kappe, and Knuiman 2022; Wissing et al. 2022; Xerri, Radford, and Shacklock 2018).

Study effort and study engagement as mediators of the association between positive relationships and academic performance

Above presented empirical findings demonstrate firstly that positive supportive contact with teachers and peers is a valid predictor of academic performance, secondly that supportive relationships are related to both study effort and study engagement, and thirdly that both study effort and study engagement are related to students’ academic performance. Therefore, it seems plausible that students’ effort and engagement are underlying mechanisms (i.e., mediators) in the association between positive relationships and academic performance. This is also suggested in a theoretical framework on student success in higher education by Kahu and Nelson (2018) and more recently by Lesener et al. (2020) and Salmela-Aro, Tang, and Upadyaya (2022) with the motivational process of their Study Demands-Resources theories. Study-related resources like positive

student-teacher relationships and positive student-peer relationships are assumed to impact students' study effort and engagement with learning. Subsequently, effort and engagement are assumed to positively impact outcomes like students' academic performance.

It is notable that, despite the general assumption of the mediating role of study effort and study engagement, relatively few empirical studies have investigated whether these factors act as mediators in the association of student-teacher and student-peer relationships with academic performance. Wild, Rahn, and Grassinger (2020), for example, found that students' commitment to their study programme mediated their perceptions of the quality of teaching and their later academic achievement. To the best of our knowledge, no studies published on higher education have focused on study effort as a mediator between positive student-teacher and student-peer relationships and performance. Slightly more is known about study engagement as mediator, in line with the earlier mentioned Study Demands-Resources theories (Lesener et al. 2020; Salmela-Aro, Tang, and Upadyaya 2022). For example, Salanova et al. (2010) and Siu et al. (2021) found that engagement partly explains the association between social support and academic performance. The study of Smithikrai et al. (2018) showed that both relationships with teachers and peers had an indirect positive effect on academic performance through more study engagement. Additionally, Ma and Wei (2022) found that study engagement mediated the relationship between classroom climate and academic performance. These studies argue for study engagement as a valid mediator of the associations of student-teacher and student-peer relationships with academic performance, although all were cross-sectional studies which give only weak evidence for causal relationships between variables. Moreover, although engagement is studied well among younger children (Roorda et al. 2017; Wentzel et al. 2017), less is known about higher education students (Farr-Wharton et al. 2018). This study advances the literature by positioning study effort and study engagement as interconnected mediators in the association relationship of positive student-teacher and student-peer relationships with academic performance.

Furthermore, little is known about the long-term impact of positive relationships, effort and engagement on academic performance (Salmela-Aro, Tang, and Upadyaya 2022), i.e., whether the associations between positive relationships, study effort, study engagement, and academic performance hold over time, especially among university students. The present study taps into this research gap by examining the longitudinal associations between student-teacher relationships, student-peer relationships, study effort, study engagement, and academic performance among university students.

The present study

This study employed a longitudinal research design to investigate the impact of student-teacher and student-peer relationships on academic performance (i.e., GPA), mediated by study effort and study engagement among undergraduate university students. Based on the theoretical assumptions and empirical findings, we expect positive associations between all study variables, i.e., student-teacher relationships, student-peer relationships, study effort, study engagement, and GPA. Additionally, we hypothesise that study effort and study engagement mediate the associations of student-teacher

and student-peer relationships with GPA. [Figure 1](#) presents a visual representation of the hypothesised links between student-teacher relationships, student-peer relationships, study effort, study engagement, and students' GPA.

By addressing gaps in the literature, this study contributes to the growing research on the interplay between important factors for academic success in higher education. Understanding the mediating role of study effort and engagement in the association of student-teacher and student-peer relationships with academic performance by longitudinal data strongly informs further theoretical frameworks and institutional strategies aimed at fostering students' effort, engagement and performance in higher education.

Method

Procedure

This paper is part of a larger longitudinal research project (see [Vollmann et al. 2022](#) for a detailed description of the procedure and data collection) investigating the learning experiences of Dutch university students during the academic year 2020/2021 in which emergency remote teaching ([Hodges et al. 2020](#)) was implemented. Data used in this study were collected at two time points: between November-December 2020 (t1) and in March 2021 (t2). Full-time students until the age of 30 years old from all 13 conventional Dutch public universities were eligible to participate via the online survey platform Qualtrics. Students were recruited via postings on social media of universities and study-related organisations as well as via emails sent by diverse student associations to their members. They received information about the goal of the study, the study procedure, and ethical aspects, such as voluntary participation and anonymised data handling. Students provided informed consent before continuing with the survey questions. As compensation, students who fully completed the surveys received a small monetary gift voucher. To obtain a heterogenous sample, sampling quotas were applied for university, study phase, gender, and migration background. The study protocol was approved by the Medical Ethics Review Committee of the Erasmus Medical Center [#2020-0815].

Participants

A total of 613 undergraduate students fully completed both surveys and were included in the analyses. The sample consisted of 416 females (67.9%), 196 males (32.0%), and 1 student who identified as non-binary (0.2%), with an age ranged between 17 and 28 years ($M = 20.18$; $SD = 1.69$). Undergraduate students from all conventional Dutch public universities participated. The participants were enrolled in a variety of course programmes and were in their first ($n = 152$, 24.8%), second ($n = 235$, 38.3%), or third ($n = 226$, 36.9%) undergraduate year. The largest part of students were native Dutch ($n = 529$, 86.3%); only a small percentage had a migration background ($n = 42$, Western: 6.9%; $n = 42$, Non-Western: 6.9%). While our sample was representative (less than 5% deviation) of the Dutch student population regarding university affiliation, male students and students with a migration background were underrepresented (see [Appendix 1](#); [DUO 2023](#); [Statistics Netherlands 2023](#)).

Measures

The surveys were administered in Dutch. To avoid missing data, all items were mandatory and could not be skipped.

Student-teacher relationships and student-peer relationships were assessed at t1 and t2 using 16 items that were adapted from existing measures (van Herpen et al. 2020; Wallace 2003). For each type of relationship, 4 items captured formal interaction (e.g., ‘I talk to the teacher about my gained insights.’ and ‘I talk to fellow students and discuss course material or assignments.’), while 4 items captured informal interaction (e.g., ‘I sometimes share personal stories with my teachers.’ and ‘I am engaged with my fellow students.’). Items were scored on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Items were recoded if appropriate and averaged with higher scores indicating better student-teacher and student-peer relationships, respectively. Cronbach’s alpha was .82 and .83 for student-teacher relationships as well as .88 and .89 for student-peer relationships at t1 and t2, respectively.

Study effort was measured at t1 and t2 with 3 items of the Effort Scale (van Herpen 2019), which is an adaptation of the school effort scale by Butler (2007). Items (e.g., ‘I put forth a high level of effort in class.’) were scored on a 7-point Likert scale ranging from 0 (never) to 6 (always). Items were averaged with higher scores indicating greater study effort. The effort scale (and adaptations thereof) has been assessed on validity and reliability in previous studies (Butler 2007; van Herpen 2019). In the present study, Cronbach’s alpha was .75 at t1 and .83 at t2.

Study engagement was measured at t1 and t2 using the ultra-short Utrecht Work Engagement Scale-Student Form (UWES-3-SF; Gusy, Lesener, and Wolter 2019; Schaufeli et al. 2019), which consists of three items reflecting the dimensions vigour, dedication, and absorption. Items (e.g., ‘My studies inspire me.’) were answered on a 7-point scale from 0 (never) to 6 (always). Items were averaged with higher scores indicating greater study engagement. The reliability and validity of this scale has been confirmed in previous studies (Gusy, Lesener, and Wolter 2019; Schaufeli et al. 2019). In the present study, Cronbach’s alpha was .77 at t1 and .80 at t2.

Academic performance was measured on t2 using students’ self-reported average of the grades they have received since the beginning of the current academic year (GPA) on a scale from 0 to 10.

Data analyses

Data were analysed using IBM SPSS v.29 and Mplus v8.9. Firstly, Pearson correlations between all study variables were computed to examine their bivariate associations. Subsequently, the hypothesised model (see Figure 1) was tested separately for student-teacher and student-peer relationships using path analysis based on multiple regression analysis with maximum likelihood estimation. Path analysis is a widely used statistical approach that allows for the examination of complex associations among multiple variables and provides insight into whether collected data are consistent with the proposed model (Streiner 2005). The statistical significance of the indirect effects of the independent variable at t1 on the dependent variable at t2 via the mediator(s) was estimated using bootstrapping with 10,000 bootstrap samples. This procedure is recommended by many

statisticians (e.g., Hayes 2009). because simulation studies have shown that bootstrapping is a valid and powerful method for testing indirect effects by providing highly accurate estimates of confidence intervals. Finally, multiple-group analyses (Kline 2023) were performed to examine whether the models are invariant across first-, second-, and third-year students, male and female students (non-binary respondent was excluded) as well as students with and without migration background. To this end, the models were estimated with group-specific path estimates (unconstrained models) and with equal path estimates across groups (constrained models). The models were compared by using χ^2 difference tests, with non-significant results indicating that the estimated parameters can be considered equal across the groups.

Results

Bivariate associations between study variables

Table 1 presents the correlations between all study variables. The perceived student-teacher relationships and student-peer relationships at t1 and t2 were positively related to GPA at t2 as well as to study effort and engagement at t1 and t2. Additionally, study effort and engagement at t1 and t2 were positively associated with each other and with GPA at t2. Finally, the strength and direction of the intercorrelations between student-teacher relationships, student-peer relationships, study effort, and study engagement, as well as their correlations with GPA are comparable at t1 and t2.

Total, direct, and indirect effects of student-teacher relationships on GPA

The results of the tested model regarding student-teacher relationships are displayed in Figure 2. Overall, the fit indices indicate a good fit of the data to the hypothesised structure, $\chi^2(2) = 0.52$, $p = .770$; CFI = 1.00; TLI = 1.00; SRMR = .004; RMSEA = .000.

There was a significant positive total and direct effect of student-teacher relationships at t1 on GPA at t2, indicating that better student-teacher relationships at t1 result in a higher GPA at t2.

Additionally, four specific indirect effects of student-teacher relationships at t1 on GPA at t2 were significant, i.e., through 1) study effort at t1 and t2, $\beta = .01$, BC 95% CI [.002, .027]; 2) study engagement at t1 and t2, $\beta = .02$, BC 95% CI [.006, .038]; 3) student-teacher relationships at t2 and study effort at t2, $\beta = .01$, BC 95% CI [.002,

Table 1. Descriptive statistics of and intercorrelations among study variables ($N = 613$).

	2	3	4	5	6	7	8	9	M (SD)
1 Student-teacher relationships t1 ^a	.27***	.10*	.26***	.65***	.18***	.11**	.21***	.19***	2.47 (0.75)
2 Student-peer relationships t1 ^a		.20***	.24***	.25***	.67***	.12**	.14***	.12**	2.97 (0.90)
3 Study effort t1 ^b			.56***	.05	.14***	.59***	.43***	.25***	4.01 (1.01)
4 Study engagement t1 ^b				.16***	.19***	.36***	.61***	.20***	2.54 (1.10)
5 Student-teacher relationships t2 ^a					.27***	.13**	.21***	.15***	2.43 (0.72)
6 Student-peer relationships t2 ^a						.15***	.16***	.13***	2.90 (0.89)
7 Study effort t2 ^b							.56***	.31***	3.81 (1.14)
8 Study engagement t2 ^b								.29***	2.38 (1.08)
9 GPA t2 ^c									6.88 (1.02)

Note. ^a scale range: 1-5, ^b scale range: 0-6, ^c scale range 0-10.

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

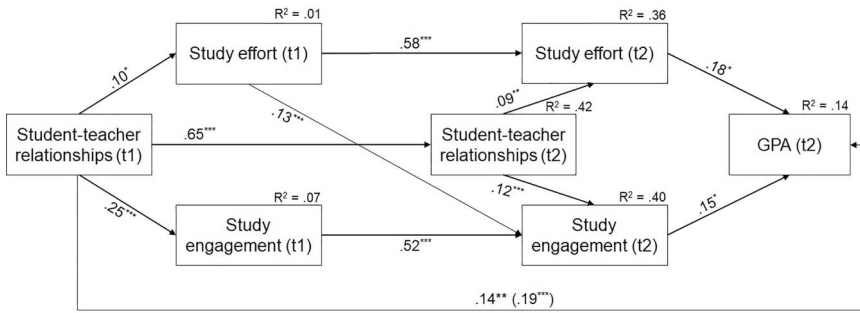


Figure 2. Results of the tested mediation model with student-teacher relationships ($N = 613$). Coefficients are reported in standardised form. The coefficient in parentheses represents the total effect. Non-significant paths are omitted for figure clarity. Significant indirect effects are indicated by bold printed paths. * $p < .05$, ** $p < .01$, *** $p < .001$.

.027]; and 4) student-teacher relationships at t2 and study engagement at t2, $\beta = .01$, BC 95% CI [.002, .025]. The two former indirect effects indicate that better student-teacher relationships at t1 are associated with more study effort and engagement at t1, which in turn are related to more study effort and engagement at t2, which in turn result in a higher GPA at t2. The two later indirect effects indicate that better student-teacher relationships at t1 are associated with better student-teacher relationships at t2, which in turn are related to more study effort and engagement at t2, which in turn result in a higher GPA at t2.

Total, direct, and indirect effects of the student-peer relationships on GPA

The results of the tested model regarding student-peer relationships are displayed in Figure 3. Overall, the fit indices indicate a good fit of the data to the hypothesised structure, $\chi^2(2) = 5.07$, $p = .079$; CFI = .998; TLI = .977; SRMR = .011; RMSEA = .050.

There was a significant positive total effect of student-peer relationships at t1 on GPA at t2, indicating that better student-peer relationships at t1 result in a higher GPA at t2.

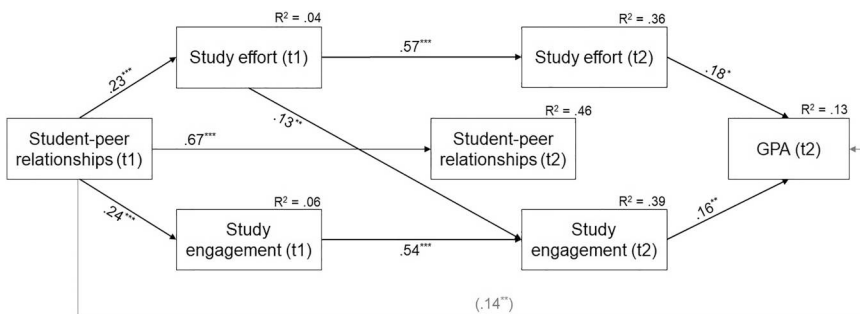


Figure 3. Results of the tested mediation model with student-peer relationships ($N = 613$). Coefficients are reported in standardised form. The coefficient in parentheses represents the total effect. Non-significant paths are omitted for figure clarity. Significant indirect effects are indicated by bold printed paths. * $p < .05$, ** $p < .01$, *** $p < .001$.

No significant direct effect of the student-peer relationships at t1 on GPA at t2 were found when the mediators were entered in the model. However, the total indirect effect of student-peer relationships at t1 via all possible mediation paths on GPA at t2 was significant, $\beta=.10$, BC 95% CI [.030, .173].

A further inspection revealed that three specific indirect effects of student-peer relationships at t1 on GPA at t2 were significant, i.e., through 1) study effort at t1 and t2, $\beta=.02$, BC 95% CI [.005, .042], 2) study engagement at t1 and t2, $\beta=.02$, BC 95% CI [.007, .040], and 3) study effort at t1 and study engagement at t2, $\beta=.004$, BC 95% CI [.001, .010]. The two former indirect effects indicate that better student-peer relationships at t1 are associated with more study effort and engagement at t1, which in turn are related to more study effort and engagement at t2, which in turn result in a higher GPA at t2. The later indirect effect indicates that better student-peer relationships at t1 are associated with more study effort at t1, which in turn is related to more study engagement at t2, which in turn results in a higher GPA at t2.

Model invariance across student groups

The results of the multigroup analyses are presented in Table 2. The analyses revealed that both models can be considered equal for first-, second-, and third-year students, male and female students as well as students with and without migration background.

Discussion

In a longitudinal design, the present study investigated the effect of the relationships of students with teachers and peers on their academic performance, mediated by study effort and study engagement.

Consistent with the literature (Hagenauer and Volet 2014; Ma and Wei 2022; Martínez et al. 2019; Salanova et al. 2010; Schneider and Preckel 2017; Tomás-Miquel, Expósito-Langa, and Nicolau-Juliá 2016; Virgă, Pattusamy, and Kumar 2022; Vollmann, Scheepers, and Hilverda 2024), we found that the relationships with teachers and peers, study effort, and study engagement positively affect students' academic performance at university. Our findings also align with previous research (cf. (Campbell et al. 2009;

Table 2. Results of the multigroup analysis.

	Model with student-teacher relationships		Model with student-peer relationships	
	χ^2 (df)	χ^2_{diff} (df _{diff})	χ^2 (df)	χ^2_{diff} (df _{diff})
Study year (first/second/third)				
Constrained model	55.86 (44)	49.58 (38)	59.85 (44)	52.43 (38)
Unconstrained model	6.24 (6)		7.42 (6)	
Gender (male/female)				
Constrained model	27.78 (23)	23.64 (19)	28.78 (23)	23.12 (19)
Unconstrained model	2.14 (4)		5.66 (4)	
Migration background (no/yes)				
Constrained model	25.18 (23)	20.03 (19)	32.55 (23)	26.84 (19)
Unconstrained model	5.15 (4)		5.71 (4)	

Note: none of the χ^2 and χ^2_{diff} -values is significant.

Descals-Tomás et al. 2021; Farr-Wharton et al. 2018; Jacquemart, De Clercq, and Galand 2024; Ma and Wei 2022; Sun et al. 2022; Wissing et al. 2022) showing that supportive relationships with teachers and peers significantly facilitate students' effort and engagement. The findings collectively corroborate previous research indicating that both types of relationships are important predictors of affective–cognitive and behavioural aspects of students' learning and of students' academic performance.

More importantly, the present findings contribute to the existing body of research by elucidating the underlying mechanisms of the performance-enhancing effect of supportive relationships with teachers and students. The results indicated that positive relationships with teachers and peers at t1 were associated with greater study effort and engagement at t1. This, in turn, resulted in greater study effort and engagement at t2, which ultimately led to better academic performance at t2. Our findings emphasise the importance of both supportive student-teacher and supportive student-peer relationships for students to invest effort in their studies and feel engaged with their studies on the short and long run. This, in turn, facilitates them to perform better. Previous research has demonstrated that study engagement can function as a mediator between contact with teachers and peers and GPA (Ma and Wei 2022; Salanova et al. 2010; Siu et al. 2021). The present study also provides evidence for study effort as an underlying mechanism that explains the positive effect of supportive contact with teachers and peers on academic performance.

In addition, the results showed an indirect effect of student-teacher relationships t1 on GPA via student-teacher relationships t2, effort and engagement. Although students may have had different teachers at each measurement point, consistently positive experiences with teachers encourages students to exert effort and become engaged with their studies. This suggests that university teachers can capitalise on previous positive interactions with students to maintain their engagement with their studies. Moreover, with each new course, teachers appear to have the opportunity to rekindle the relationships with students and stimulate their academic performance. In primary and secondary education, positive, supporting contact between teachers and students is regarded as an essential aspect of the learning environment. In higher education, however, the importance of this aspect is underestimated (Hagenauer, Muehlbacher, and Ivanova 2023; Hagenauer and Volet 2014). This study underlines the notion that supportive relationships with teachers can motivate students to perform better, and to invest effort and enthusiasm in their studies. This highlights the need to recognise and reward teachers who (want to) prioritise pedagogical and affective aspects of university teaching.

Student-peer contact mainly affected GPA indirectly via effort and engagement. This suggests that when students cooperate with each other for courses, discuss study materials, and feel connected with each other, they achieve better grades. Furthermore, the results indicate that early positive relationships with fellow students have a long-term positive impact on study behaviour and performance. The student-peer relationships at t2 no longer affected students' effort and engagement, nor their academic performance. However, the student-peer relationships at t1 did affect academic performance, via effort and engagement at t1 and t2. It can therefore be concluded that the establishment of supportive peer relationships at the outset of the academic journey is of significant importance for students' study progress (cf. (Brouwer et al. 2016; Lomi et al. 2011; Stadtfeld

et al. 2019; Tomás-Miquel, Expósito-Langa, and Nicolau-Juliá 2016), especially during situations of remote education as during the covid-19 pandemic.

Moreover, a significant positive association was found between study effort at t1 and study engagement at t2, suggesting that how hard students are willing to work at t1 influences their engagement with their studies at t2. Earlier research is inconclusive regarding the relationship between effort and engagement (Cook and Artino 2016; Kahu and Nelson 2018; Salmela-Aro, Tang, and Upadyaya 2022). Motivation theories (see Cook and Artino 2016) like the expectancy-value theory posits engagement and effort together as observable behaviour before academic achievement. Goal orientation theory posits that if a student invests significant effort in their studies but is not rewarded with a satisfactory grade and/or positive feedback from teachers or peers, this can lead to disengagement. Our results indicate that effort at t1 has a positive influence on engagement at t2. Consequently, students' willingness to work for their studies from the outset affects their effort and engagement, as well as their performance, at a later stage in the academic year. Therefore, encouraging students to commit to their studies from the start might serve as a preventive measure against disengagement and academic failure at a later stage.

It should be noted that both models explained only a small proportion of the variance in academic performance. However, this is not surprising given the complexity of factors and processes influencing academic performance. Notably, other variables known to be substantial predictors of academic performance, e.g., past performance, personality, motivation, and course organisation (Richardson, Abraham, and Bond 2012; Schneider and Preckel 2017) were not included. Nevertheless, the results of this study give a more detailed insight into how academic performance is influenced by the interplay of three central concepts in higher education literature and practice, namely relationships with teachers and peers, study effort, and study engagement.

Practical implications

The study contributes to our understanding of how we can model the relationships with teachers and peers, study effort and study engagement as important predictors of students' academic achievements. The results of this study suggest a significant role of study effort and study engagement as clarification of the relationship between students' experienced contact with teachers and peers and their academic performance.

Both types of relationships are important in stimulating students' learning behaviour and positive feelings about studying, and consequently for their academic performance. Teachers should bear this in mind when designing their courses, for example by creating learning tasks that include cooperation (cf. Johnson, Johnson, and Stanne 2000) and differentiation to engage a diverse body of students (cf. Tomlinson and Imbeau 2010). Creating challenging, complex cooperative learning tasks in which talents of different students are necessary to complete the task and include some freedom for students to choose what (content) and how (process) they want to learn and how to show what they have learned (product or assessment) could stimulate students' effort and engagement for learning.

Our results also suggest that especially during the situation of emergency remote teaching like COVID-19 in which communication and interaction is hindered,

universities should invest in facilitating frequent and meaningful interactions between students and their teachers and peers. Formal and informal contact with significant others in the learning context is vital to enjoy studying, put in effort, and perform well at university. This should be considered when future lockdowns happen or post-covid blended learning environments are (re)designed (cf. McKenna et al. 2020; Snowball 2014).

Strengths and limitations

The present study provides new insights into the associations between student-teacher and student-peer relationships, study effort, study engagement, and academic performance of university students. One strength of the study is the longitudinal design which allows examining effects over time. Another strength is the heterogeneity and largely representativity of the sample including students from all Dutch public universities. This contributes to the external validity and generalizability of the findings.

However, some limitations need to be mentioned. First, the findings in this study may be distorted by the fact that self-reported scores on GPA were used. Self-reported GPA is widely used in research and reasonably reliable of actual grades in students with high and good grade point averages (Kuncel, Credé, and Thomas 2005). We should, however, be cautious regarding the representation of students with low GPA or low ability. Moreover, we did not control for previous academic performance, which has been shown to be predictive of subsequent study behaviours and academic success (Cerdeira et al. 2018; Kryshko et al. 2020; Schneider and Preckel 2017; Valadas, Almeida, and Araújo 2017; van Herpen et al. 2017).

Second, although the study employed a longitudinal design, the tested models include causal paths that are based on cross-sectional data collected at the same time point, specifically the effects of student-teacher and student-peer relationships on study effort and study engagement at t1 and t2. The proposed temporal order of the variables is derived from theoretical assumptions and previous empirical findings. However, with cross-sectional data, the direction of causality cannot be determined (Winer et al. 2016). It is reasonable to assume that the associations of student-teacher and student-peer relationships with study effort and study engagement are reciprocal (cf. Becker et al. 2014). The use of experimental designs (comparing current versus improved quality of interaction between students, teachers and peers) or multi-wave longitudinal studies using ecological momentary assessments could help to clarify the causal pathways.

A third limitation might be the context of emergency remote teaching during the COVID-19 pandemic which could impair the generalisability of our findings to non- or post-covid higher education contexts. The lockdowns certainly had a negative overall impact on students' relationships with teachers and peers, study engagement, study effort, and academic performance (Vollmann et al. 2022). However, there is no reason to assume that the strength and/or direction of the associations between student-teacher and student-peer relationships, study effort and engagement, and academic performance were systematically altered by the pandemic-induced changes in university education. This is supported by the observation that the bivariate associations between the variables found in our study are consistent with the theorised hypotheses and comparable to empirical findings from the pre-pandemic era (Campbell et al.

2009; Farr-Wharton et al. 2018; Kryshko et al. 2020; Ma and Wei 2022; Salanova et al. 2010; Schaufeli et al. 2002; Schneider and Preckel 2017). In fact, our findings give the field of higher education a contemporary perspective on students' experience during emergency remote teaching and give further insight into how relationships, study effort, study engagement, and academic performance are associated over time. Nonetheless, replication in future research is recommended.

Finally, the question remains whether the found models fit in different higher educational contexts. This study was conducted among students from public universities. Additionally, in-class interactions between teachers and students in the Netherlands commonly show a different power distance than in, for example, eastern countries (Rienties and Tempelaar 2013). Therefore, future studies should investigate whether this model holds true in other higher educational institutions and in different cultural contexts.

Conclusions

This study showed that supportive relationships with teachers and peers have a favourable effect on students' academic performance in higher education. Furthermore, supportive relationships with teachers and peers positively influence students' effort and engagement for their studies. Most importantly, study effort and study engagement mediate the effect of student-teacher and student-peer relationships on performance. The results were consistent across the full sample, students in different years of study, males and females, and students with and without a migration background. In particular, when students experience their contact with teachers and peers as positive, they work harder and feel more engaged with their studies, which consequently results in better academic performances. These findings highlight the importance of investing in meaningful relationships between students, teachers, and their peers to promote effective learning behaviour and performance in higher education.

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Author contributions

All authors contributed to the study conceptualisation and prepared the material. Data collection was coordinated by FH and MV. Data were analysed and interpreted by MV. The manuscript was drafted and critically revised by all authors. All authors read and approved the final manuscript.

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Data availability statement

Data used in this study are available in the Erasmus University Repository. <https://doi.org/10.25397/eur.19752967>

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