



Development of students' subject interest at university: analysis of students' predictors and lecturers' attitudes towards the characteristics of a successful university

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Abstract

Longitudinal research on students' interest in higher education showed that interest declines throughout the study program. While researchers reported numerous factors explaining interest on the student level, research on the relationship between the lecturer level and students' interest development is considered scarce. This study aimed to analyze the relationships between lecturer level, such as attitudes toward academic success, and at the student level, such as gender, on students' development of subject interest. To achieve this, two datasets were merged and analyzed: one from a panel study of annual assessments comprising 12,116 measurement points from 5491 cooperative students in Germany, and the other from a survey of the students' lecturers from 22 different departments, using three-level growth curve modeling. The results showed a decline in subject interest over the study program and showed that academic discipline and gender explained the development of subject interest. However, lecturers' attitude to academic success was not related to their students' development of subject interest. These findings confirmed the importance of developing interest programs for students to keep interest high.

Keywords Interest · University students · Longitudinal analysis · Lecturer, Academic success

In educational programs, such as school or university, numerous studies have indicated a decline of interest over time (Benden & Lauermann, 2022; Brahm et al., 2017; Gaspard et al., 2020). Interest is defined as “a unique motivational variable, as well as a psychological state that occurs during interactions between persons and their objects of interest, and is characterized by increased attention, concentration and affect” (Hidi, 2006, p. 70). Research conducted at universities has identified an

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association between interest and academic outcomes, such as dropout rates (Schnettler et al., 2020; Wild et al., 2023a), study performance (Richardson et al., 2012; Schneider & Preckel, 2017), and continuation to master's level studies (Harackiewicz et al., 2002). Previous research has also highlighted that interest is easier to change than other predictors of achievement (e.g., cognitive ability or socioeconomic background) (van Maurice et al., 2014).

Factors related to the development of interest have been mostly been discussed in the school context, focusing on the student level (Frenzel et al., 2010; Lazarides et al., 2019; Wentzel & Miele, 2016; Wild et al., 2023b). Dotterer et al. (2009) emphasized that most previous studies used cross-sectional data or short-term longitudinal designs. Longitudinal research on the development of student interest at university has received too little attention, and studies tend to focus only on student-level predictors (Janke et al., 2022; Liebendörfer & Schukajlow, 2017). Additionally, there is a lack of research on the motivation of department members, such as intrinsic value and interest, and on the impact of lecturers, such as their attitudes, on students' interest development (Daumiller et al., 2020). Based on the findings of social psychology, relevant group context factors that influence the individual should also be integrated into the research (Bordens & Horowitz, 2013). There is a need for deeper analyses in this research field (Jansen et al., 2022; Xu et al., 2021) and for the use of more objective administrative (or institutional) data (Fredricks et al., 2019) to reduce measurement errors and social desirability bias.

Taken together, this study aims to investigate the relationships between factors at the student and lecturer level on the development of students' interest. This research provides empirical evidence on an understudied topic by testing the effect of higher-level factors, in particular lecturers' attitudes that characterize a successful university, on the development of subject interest. This study also examines the factors that mitigate the decline in interest. It builds on and extends the current state of research in the context of the person-object theory of interest (POI; Krapp, 2007). More specifically, the aim was to analyze the prediction of student level, such as academic discipline, gender, and the level of lecturers' attitudes toward academic success, on the students' development of subject interest, as an important motivational aspect. Furthermore, a longitudinal research design and administrative dataset were used. Several assumptions were postulated and tested on a growing subpopulation, here cooperative education in Germany that doubled to nearly 120,000 students in the last decade to 2022 (Hofmann, 2023), to expand the robustness of the theoretical framework. Krapp (2007) postulates that research in vocational education overlaps with other educational settings, such as university cooperative education (Wild et al., 2023c). In cooperative education, students typically alternate between academic learning at the university (the theory phase) and practical experience in industry (the work phase). These students have an employment contract with a company from the practice (Coll & Zegwaard, 2011; Wild & Neef, 2019). Kramer et al. (2011) showed that cooperative students are more motivated than students at traditional universities or universities of applied sciences on several dimensions. In this study, a three-level multilevel modeling was used, with a large sample of 22 different departments, more than 5000 university students and at least two measurement points for every student. Data collection was conducted between 2016 and 2019 and is therefore not biased by the COVID-19 pandemic.

Theoretical framework and empirical results

Interest development from a theoretical perspective

Historical perspective highlights that interest can be seen as a unique variable (Hidi, 2006). Researchers argue that interest is viewed as a link between positive cognitive and affective domains of a person for a subject (Krapp, 1999; Schiefele, 1996; Spinath, 2011). Hidi (2006, p. 70) summarizes that interest is a psychological state that is created through interactions between persons and their objects of interest, when attention, concentration, and affect increase. Furthermore, interest can lead to better comprehension, memory, attention, deeper learning, and achievement (Hidi, 2006; Renninger & Hidi, 2019).

The theoretical framework of POI describes the development of student interest as a specific interaction of the individual with the environment, either a person-object interaction (leading to the development of “individual interest”) or a person-stimulus interaction (leading to “situational interest”) (Krapp, 2007; Wild, 2023). A person-object interaction can be seen as an increasing association between an individual and a particular object, event, or idea that becomes interesting to the person (Krapp, 2002) and a person-stimulus interaction refers to the triggering of situational interest by exciting stimuli in the environment (Wild, 2023). Schiefele (2012) highlights a distinction between situational interest and individual interest. *Situational interest* is defined as a temporary emotional state in a situation, task, or object, whereas *individual interest* is a relatively stable affective-evaluative orientation toward topics or objects. In this study, we analyze subject interest and define subject interest as an interest in the topics of the given subject and a match between personal interests and learning opportunities in one's field of study (Fellenberg & Hannover, 2006). Thus, it is a specific aspect of individual interest.

The “four-phase model of interest development” (Hidi & Renninger, 2006; Renninger & Hidi, 2019; Wild, 2023) proposes four stages that integrate the situational and individual interest perspectives. In the first phase of the model, a triggered or “catch” component of situational interest exists, where a stimulus for raising persons attention is built. Secondly, a “hold” component of situational interest is presented because the person is willing to know more about the object of interest. The third phase is characterized as emerging individual interest developed through positive feelings toward the object of interest. In the final phase, individual interest is established. This phase is characterized by people reflecting on the object of interest, expanding their stored knowledge, starting their search, and creating questions about it.

The POI postulated the dual regulation system, assuming that two parallel existing components are important for interest development, (1) cognitive-rational factors, which could be seen as intentions that are used to overcome obstacles blocking a purposeful activity or intentions to accomplish an uninteresting but important task, and (2) an emotional subsystem, which could be seen as a biological system providing direct feedback on the functional state of the organism (Krapp, 2005, 2007). In particular, cognitive-rational factors are responsible for the formation of rationale-analytic intention, such as solving challenges in a goal-oriented activity or performing a necessary boring task. The emotional subsystem is seen as a feedback of experience for actual effort in a situation (Krapp, 2005).

Krapp (2007) stated in a theoretical discussion of POI that modeling interest development requires the analysis of intra-individual differences as a prerequisite. He suggested that, especially for vocational training, longitudinal analyses are essential for detailed knowledge of individual interest development and its influencing factors. More research is

needed in this area to identify developmental principles at the micro level, focusing on the quality of learning and linking to more global phenomena such as identity formation and/or personal growth (Krapp, 2007, p. 18).

We expected to find associations between lecturer-level variables and students' interest development. Based on the model of productive processing of reality (Hurrelmann & Bauer, 2018; Hurrelmann & Richter, 2019), these associations can be considered an effect of the university socialization (Horstkemper & Tillmann, 2008) on students' personality development. In particular, lecturers' attitudes toward academic success could influence lecturer's behavior, which in turn could explain students' interest development. Empirical evidence from school research illustrates such links between the teacher level and the student level, e.g., teachers' beliefs about the usefulness of effort can explain student achievement (Ekmekci & Serrano, 2022; Muis & Foy, 2010).

Empirical findings on situational interest development

Numerous empirical results underline the importance of the dual regulation framework in POI and provide an overview of the factors affecting interest (Krapp, 2005; Wild et al., 2024a; Xu, 2008, 2018). First, rational factors, such as performance or decisions in education, are related to interest components (Gabay-Egozi et al., 2010; Graeff et al., 2014). However, causality is shown in both directions (Jansen et al., 2016; Rotgans & Schmidt, 2011; Scherrer et al., 2020; Schiefele et al., 1993; van Maurice et al., 2014; Wild et al., 2023b) as performance before entering university also influences the change of interest (Robinson et al., 2019). Moreover, components of the emotional subsystem are empirically related to interest (Krapp, 2005; Wild et al., 2023b). In the context of school research, previous empirical studies show that perceived teacher support and teacher enthusiasm lower the decline in interest (Dietrich et al., 2015; Lazarides et al., 2019; Wild et al., 2023b). Furthermore, the quality of instruction in higher education is also related to interest (Wild, 2023).

For the relationships between demographic variables and interest development, such as gender, inconsistent results have been found. In Science, Technology, Engineering, and Mathematics (STEM), there is a trend indicating that male students show higher interest than female students (Benden & Lauermaun, 2022; Frenzel et al., 2010; Robinson et al., 2019; Stolk et al., 2021). In contrast, other studies, such as a meta-analysis conducted in Turkey between 2004 and 2019, have found only a small association between gender and motivational differences (Turhan, 2020). Moreover, stronger intrinsic motivation was found for female students in the academic discipline of Economics (Arnold & Rowaan, 2014).

In an extended view, the approach of Robinson (2023) elaborates that mastery goals, autonomy, and competence positively predict students' intrinsic value trajectories, whereas higher perceived instructor performance goals are negatively associated with intrinsic value trajectories (Robinson et al., 2022a). Further research on the motivational aspects of expectancy for success and attainment value, according to situated expectancy-value theory, shows that perceived instructor relevance to real life and enthusiasm predict the trajectories of these task values (Robinson et al., 2022b). Marchand and Gutierrez (2017) report similar findings and Wild et al. (2024b) show that perceived lecturer support mitigates the decline in subject interest.

There is a lack of research that applies a multilevel design to examine the factors that influence interest development at the student level, including, for example, the effects of the instructor level. School research has shown that contextual variables can

explain academic achievement. In line with Marzano (2001), it is reported that students' achievement has an explained variance from 80% from student personal background, 13% from teacher level, and 7% from school level. Further meta-analysis by Hattie (2003) showed an explained variance of 30% by teacher level and 50% explained variance by individual student level on their achievement.

Objective

The purpose of this study was to examine the factors that influence students' interest in university in order to reduce the decline in interest by using longitudinal data. Based on POI, we expected different effects for predictors on the student level (Krapp, 2002). In particular, we postulated associations based on the theoretical background of dual regulation system effects. We assumed that cognitive-rational factors, especially performance, were related to students' subject interest. The emotional subsystem, especially quality of instruction and perceived support, predict students' subject interest. Gender is considered to be a relevant demographic variable that is likely to influence the emotional competencies and behavior according to the social role theory (Eagly & Wood, 2012; Ifegbesan & Azeez, 2024). In particular, there is evidence for different emotional behavior of female and male persons (Durik et al., 2006; Givon et al., 2023). The following difference hypotheses and correlation hypotheses are tested:

Hypothesis 1a: Higher performance before the study program is positively associated with students' subject interest.

Hypothesis 1b: Higher performance during the study program is positively associated with students' subject interest.

Hypothesis 1c: Higher perceived quality of instruction has a positive association with students' subject interest.

Hypothesis 1d: Higher perceived support is positively associated with students' subject interest.

Hypothesis 1e: Female students' interest differs from that of male students.

The current state of research is too imprecise to formulate Hypothesis 1e more precisely. In addition, we considered other factors at the lecturer level in our analyses. Based on the aspect of person-object interaction, in detail, that environment leads to the development of "individual interest" (Krapp, 2007), we assumed that lecturers' attitude toward academic success as well as the academic discipline influenced students' interest. Therefore, we formulated the following hypotheses:

Hypothesis 2a: Lecturers' attitude to academic success is positively associated with students' subject interest.

Hypothesis 2b: Students' subject interest varies across different academic disciplines.

Research results are too imprecise to formulate Hypothesis 2b more precisely. In the next step, we investigated the development of the subject interest. Here we investigated the developmental trend of interest in the subject and analyzed which factors influence this development. We tested the following hypotheses of change:

Hypothesis 3: Students' subject interest declines from the beginning to the end of the study program.

Hypothesis 4a: Female students show different developmental trajectories of students' subject interest compared to male students.

Hypothesis 4b: Academic disciplines of Economics, Engineering, and Social Work show different developmental trajectories of students' subject interest.

Hypothesis 4a and hypothesis 4b cannot be formulated in more detail because the current state of research has reported contradictory empirical evidence.

Methods

Participants and design

The current study used data from the study "Study Process – Crossroads, Determinants of Success and Barriers during a Study at the DHBW" (Deuer et al., 2020). The project aimed to analyze factors contributing to academic success in cooperative higher education at Baden-Wuerttemberg Cooperative State University (DHBW). We merged data from a survey of lecturers and from the annual panel study of students to test our hypotheses. Participation in the surveys of the project was voluntary, and the participants were reassured that their information would remain anonymous and confidential. Participants had also provided their informed consent. This research was conducted following the principles of the Declaration of Helsinki (World Medical Association, 2013), approved by Baden-Wuerttemberg Cooperative State University on July 8th, 2015, and by local heads of the research groups for ethical standards.

According to Wild and Neef (2019) and Wild et al. (2023b), cooperative students alternated between academic learning at the university (the theory phase) and practical experience in the industry (the work phase), in contrast to traditional university studies. This cooperative education bachelor's study program comprised 210 ECTS (European Credit Transfer System) credit points, with a standard graduation time of six semesters (3 years). Enrollment was only possible each October with a company contract.

The cross-sectional survey of lecturers was conducted in December 2018. Data was collected online from 287 lecturers at 12 locations, each with up to three departments. We aggregated these combinations of location and departments into 22 units on the third level. For example, a lecturer belonging to Stuttgart (location) and to the faculty of Social Work (department) was considered one unit. Data in the third level have $M = 13.05$ ($SD = 8.97$) lecturers for every unit in the third level. Most lecturers had been working in their respective location for more than 10 years ($Median \geq 10$).

Data collection at the student level followed an annual panel design with four waves from 2016 to 2019. Researchers invited all 34,000 enrolled students at the DHBW. Deuer et al. (2020) and Wild et al. (2023b) reported a response rate of approximately 20% for online data collection, with the first wave completed in July 2016 (response rate 19.7%), panel wave 2 in March 2017 (response rate 18%), panel wave 3 in March 2018 (response rate 24.3%), and finally panel wave 4 in March 2019 (response rate 22%). Table 1 presents the patterns of unit non-response from participating students by gender and academic discipline in our study. Only data from students who participated at least twice were included in the analysis to statistically model change. Unit non-response was not a major problem

Table 1 Participation rates and missing data patterns in student panel waves

2016	2017	2018	2019	<i>N</i>	<i>Gender</i>		<i>Academic discipline</i>		
					% female	% male	% Economics	% Engineering	% Social Work
X	X	X		513	57.9	42.1	57.8	28.7	13.5
X	X			981	54.4	45.6	57.6	29.9	12.5
X		X		415	51.3	48.7	57.4	34.2	8.4
	X	X		959	57.2	42.8	57.8	30.1	12.1
	X	X	X	621	62.2	37.8	59.6	28.0	12.4
	X		X	248	57.3	42.7	57.2	32.3	10.5
		X	X	1,758	57.6	42.4	56.4	29.6	14.0

X participation in wave

for the hierarchical linear model technique, as unbalanced design was used in this analysis (Bryk & Raudenbush, 1992). Over 1000 students participated in all three waves. Low participation rates were evident in the patterns when participants skipped a wave ($n=248$ to 415). More women than men participated in the combinations, or in other words men are less likely to take part in a survey if a panel wave is skipped. Academic discipline showed a distribution of about 60% Economics, 30% Engineering, and 10% Social Work. Further analysis for all participants in the sample show a significant association between gender and academic discipline ($\chi^2(2)=831.38$, $p<0.001$, *Cramér's V*=0.39). Female students were more likely to enroll in Social Work ($z=10.3$) and Economics ($z=5.9$) and less likely to enroll in Engineering ($z=-14.8$).

Measures

In this section, we describe the measurement instruments used. Wherever possible, we utilized McDonalds' omega to estimate internal consistency (McDonald, 1999). A value of $\omega \geq 0.70$ is considered satisfactory (Viladrich et al., 2017).

Lecturers' attitude to academic success

The attitude toward academic success among lecturers was measured using an instrument developed by Heublein et al. (2015). Based on the framework outlined in Heubleins' study on the "dropout from higher education process" (2014), five indicators for academic success were derived: (1) high grades achieved by students in tests, (2) a low dropout rate, (3) graduates exhibiting very high professional skills, (4) high student satisfaction, and (5) strong preparation for the requirements of the labor market. Lecturers were provided with a 5-point Likert scale to indicate their agreement with each option, ranging from 1 (strongly disagree) to 5 (strongly agree), along with a category for "no opinion." Responses marked as "no opinion" were treated as missing values. Table 2 presents the items of the scale. This variable selection is based on the main goals of higher education according to the German Council of Science and Humanities (2022), namely the training of (specialized) scientists, the preparation for the labor market preparation, and personality development. Furthermore, the debate on future skills (Ehlers, 2020) supports the selection of these variables.

Table 2 Used items, in translation and in their original German language for measuring lecturers' attitude to academic success (adapted from Heublein et al., 2015)

Item in English	Item in German
Good examination grades of students	Gute Prüfungsnoten der Studierenden
Low dropout rate	Niedrige Studienabbruchsquote
Graduates with very good professional skills	Absolventen mit sehr guten fachlichen Fähigkeiten
High student satisfaction	Hohe Studienzufriedenheit der Studierenden
Good preparation for the requirements of the labour market	Gute Vorbereitung auf die Anforderungen des Arbeitsmarktes

Introduction text: What characterises a successful university? (=English)/ Was macht Ihrer Meinung nach eine erfolgreiche Hochschule aus? (=German)

Subject interest

In our study, subject interest was measured using the instrument developed by Fellenberg and Hannover (2006) in the student panel (sample item: “My field of study matches with my interests.”). The scale consists of nine items rated on a scale from 1 (strongly disagree) to 5 (strongly agree). Reliability was good, with ω values of 0.88, 0.90, and 0.91 in academic years 1, 2, and 3, respectively.

Time

The information regarding the exact day of measurements in the student panel was collected by the survey software. We compared this data to the day the study program began. Thus, the exact number of days for which students was enrolled in the study program when they answered the survey question was available.

Performance before and during the study program

The entrance scores for German universities ranged from 1 (equivalent to an A in Great Britain (GB) and the United States of America (USA)) to 4 (equivalent to an E (GB) or D (USA)). Performance in the study program, specifically the Grade Point Average (GPA), ranged between 1 (equivalent to an A in Great Britain and the United States of America) and 5 (equivalent to an E (GB) or D (USA)), measured in every semester of the current panel wave. These two performance variables were obtained from university administration and were recoded for easier interpretation. The recoded values of university entrance scores range from 1 (lowest performance) to 4 (highest performance), and the recoded values of performance in the study program, represented as GPA, range from 1 (lowest performance) to 5 (highest performance). Thus, higher values indicate better performance. See Wild (2023) for a detailed explanation of this procedure.

Perceived support

The scale measuring perceived lecturer support was adopted from Thiel et al. (2008). Reliability analysis indicates acceptable consistency for the four items in our sample (ω was 0.76, 0.74, 0.74 in academic years 1, 2, and 3). Scores ranged from 1 (very dissatisfied) to 5 (very satisfied) on these measures. For instance, a sample item from the student panel asks: "How satisfied are you with the support and supervision provided by the lecturers in terms of assistance with learning and work difficulties?"

Perceived quality of instruction

The perceived quality of instruction was assessed using the instrument developed by Thiel et al. (2008) within the student panel. The scale ranged from 1 (strongly disagree) to 5 (strongly agree) and demonstrated good reliability ($\omega=0.79, 0.81, 0.82$ in academic years 1, 2, and 3). This scale comprised eight items (a sample item being: "In general, the courses are well structured.").

Age, gender, academic disciplines, and location of university

We received information about the year of birth, gender, academic discipline, and location of the university from the university administration for the student panel. Regarding gender, only the values of "woman" (coded as 1) and "man" (coded as 0) were available. There were three academic disciplines: Economics, Engineering, and Social Work, and a total of twelve locations. Table 1 presents details of the distribution of the variables gender and academic disciplines across each participation pattern in the waves. Lecturers self-reported their university location and academic discipline.

Data analyses and missing values

Using the nested data structure — level 1 timepoint ($N=12,116$); level 2 student ($N=5,491$; cluster size: $M=2.21$; $SD=0.40$), level 3 lecturer in a department of a location ($N=22$; cluster size: $M=550.73$; $SD=322.83$) — we performed growth curve analysis in the context of multilevel models (Magnusson, 2015; Mirman, 2014) with the "lme4" package (Bates et al., 2015) in R (R Core Team, 2024) to test our hypotheses using Restricted Maximum Likelihood (REML). To check the robustness of estimated results, we estimated different models using the "BOBYQA algorithm," optimizing iterative minimum functions (Powell, 2009). We estimated time-invariant variables by random effects and time-variant variables as fixed effects. R-square (conditional) was estimated through R^2_{GLMM} (Nakagawa & Schielzeth, 2013) using the R package "MuMIn" (Bartoń, 2023).

We also conducted likelihood-ratio tests to assess the improvement of different models. First, we analyzed intraclass correlation coefficients (ICC) at each level (Tabachnick & Fidell, 2014; Twisk, 2006) and identified $ICC \geq 0.05$ as an indicator that a multilevel model should be considered (LeBreton & Senter, 2008). We incorporate Akaike information criterion (AIC) and Bayesian information criterion (BIC) into our analyses. In the first step, we estimated an empty model that did not include any predictors (model 1). Next, we included variables at the student level, such as age, as a control variable (model 2),

predicting subject interest in the model (H1a to H1e and H3). Model 3 incorporated variables at the lecturer level (H2a to H2b). Additionally, in model 4, we exploratively tested the interaction effect of study program and gender with time on the development of students' subject interest (H4).

There were no missing values in level 3 aggregated data. Missing values due to item non-response in level 1 variables ranged from 0 to 10.9% ($M=5.25$; $SD=4.97$) with 69,104 measurements (94.76% of the sample) and 10,551 cases (86.81% of the sample) having no missing values. Similarly, analysis of level 2 variables revealed a range of 0 to 1.3% ($M=0.43$; $SD=0.75$) missing data with 16,457 measurements (99.56% of the sample) and 5437 cases (98.68% of the sample) having no missing values. We addressed these missing data using multiple imputation by chained equations with 100 imputations, using the R package "mice" (van Buuren & Groothuis-Oudshoorn, 2011), and considered the multilevel structure of the data (Grund et al., 2018).

Results

Preliminary analysis

Table 3 provides descriptive statistics, including mean, standard deviation (SD), skewness, and kurtosis. Notably, the mean for subject interest decreased significantly from the first to

Table 3 Descriptive results by academic year

	<i>N</i>	<i>M</i>	<i>SD</i>	<i>Skew</i>	<i>Kurtosis</i>
High performance of grades	22	2.02	0.37	-0.59	2.44
Low dropout rate	22	2.66	0.46	0.11	-0.60
Graduates with high professional skills	22	4.82	0.13	-0.53	0.00
High satisfaction of students	22	3.67	0.32	-0.09	-0.10
Preparation for labor market	22	4.29	0.28	0.27	-0.14
University entrance scores	5,491	2.83	0.59	-0.16	-0.56
Subject interest (t1)	3,767	3.69	0.68	-0.55	0.45
Subject interest (t2)	4,829	3.58	0.75	-0.56	0.18
Subject interest (t3)	3,520	3.54	0.78	-0.53	0.19
GPA (t1)	3,767	3.81	0.62	-0.48	-0.07
GPA(t2)	4,829	3.83	0.54	-0.37	-0.08
GPA (t3)	3,520	3.90	0.46	-0.27	-0.42
Perceived quality of instruction (t1)	3,767	3.69	0.54	-0.65	1.39
Perceived quality of instruction (t2)	4,829	3.49	0.59	-0.73	0.98
Perceived quality of instruction (t3)	3,520	3.41	0.60	-0.57	0.46
Perceived support (t1)	3,767	3.06	0.72	-0.23	0.07
Perceived support (t2)	4,829	2.93	0.74	-0.10	-0.07
Perceived support (t3)	3,520	2.90	0.75	-0.05	-0.16

t1=first academic year, t2=second academic year, and t3=third academic year. All scales range from 1 (=strongly disagree/lowest performance) to 5 (=strongly agree/highest performance). University entrance scores range from 1 (=lowest performance) to 4 (=highest performance). Performance in study program is seen as GPA (Grade Point Average) range from 1 (=lowest performance) to 5 (=highest performance)

the third academic year ($F(2, 2266) = 28.60, p < 0.001, f = 0.16$) with a small effect size, as determined by one-way repeated-measure analysis of variance (ANOVA). Similarly, the mean for perceived support decreased significantly with a small effect size from the first to the third academic year ($F(2, 2266) = 8.48, p < 0.001, f = 0.16$). Decreasing results were also obtained for the perceived quality of instruction ($F(2, 2266) = 185.94, p < 0.001, f = 0.41$) with a large effect size. The normality assumption was considered problematic for several variables (e.g., high grades with $kurtosis = 2.44$ at lecturer level 3; the perceived quality of instruction of first academic year with $kurtosis = 1.39$ at level 1). Similarly, the variable "graduates with high professional skills" of lecturer attitude to academic success (level 3) indicated a ceiling effect, owing to $M = 4.82 (SD = 0.13)$.

Table 4 displays the correlations, according to Pearson (r) among the variables. Large effect sizes, in addition to correlations within the timepoints of the same variable, were observed for indicators of academic success. These include the correlation between lecturers' high grades and graduates with high professional skills ($r = 0.54$), as well as high grades and high student satisfaction ($r = 0.53$). Furthermore, correlations between perceived quality of instruction and perceived support ranged from $r = 0.32$ to $r = 0.51$. University entrance scores and performance in study program correlated between $r = 0.35$ and $r = 0.41$. We also found a negative correlation between lecturers view of high grades and preparation for labor market ($r = -0.36$).

We observed a small effect of gender in all three academic years regarding subject interest. Male students attained higher scores than female students. Descriptive analysis results are shown in Table 5 and t -test showed significant results for academic year 1 ($t(3765) = 7.38, p < 0.001, d = 0.24$), academic year 2 ($t(4826) = 7.99, p < 0.001, d = 0.31$), and academic year 3 ($t(3519) = 8.12, p < 0.001, d = 0.28$) with small effect sizes.

One-way ANOVA revealed significant differences between academic disciplines in the academic year 1 ($F(2, 3764) = 58.77, p < 0.001, f = 0.18$), academic year 2 ($F(2, 4825) = 91.43, p < 0.001, f = 0.20$), and academic year 3 ($F(2, 3518) = 76.71, p < 0.001, f = 0.21$) with small effect sizes. Table 6 presents the descriptive analysis results. Post-Hoc Test of Games-Howell indicated that students from the academic discipline of Social Work had the highest subject interest in all academic years compared to reference groups ($p < 0.05$). In contrast, students from the academic discipline Economics had the lowest interest values compared to reference groups ($p < 0.05$).

Testing the hypotheses

To test our hypotheses, we estimated four growth curve models with three levels. Table 7 presents the results of these analyses.

First, we estimated an empty multilevel model (model 1) with no predictors. Results indicated substantial variability across different levels. We assessed the significance of this variability by estimating the ICC and their confidence intervals. Our analysis revealed that the 95% confidence intervals of the $ICCs$ were significantly different from zero, with $ICC(\text{students}) = 0.712$ (95% $CI = [0.699; 0.724]$) and $ICC(\text{department}) = 0.050$ (95% $CI = [0.029; 0.098]$). This means that in level 2, the student level, there is a higher variance in explanation regarding affiliation to a cluster than at level 3, the department level.

In model 2, individual student characteristics were incorporated ($R^2 = 0.721$; $AIC = 20,401$; $BIC = 20,519$). In this model, the emotional component of perceived support ($B = 0.068$; $p < 0.001$) and perceived quality of instruction ($B = 0.276, p < 0.001$) exhibited a significant positive association with subject interest. In fact, a one-unit

Table 4 Bivariate correlations (*r*)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 High grades	–																	
2 Low dropout rate	.45	–																
3 Graduates with professional skills	.54	.43	–															
4 High satisfaction of students	.53	.21	.07	–														
5 Preparation for labor market	–.36	–.13	–.18	–.03	–													
6 University entrance scores	–.12	–.12	–.09	–.07	.10	–												
7 Subject interest (t1)	.10	.11	.13	.05	–.03	–.05	–											
8 Subject interest (t2)	.11	.12	.15	.04	–.04	–.05	.71	–										
9 Subject interest (t3)	.13	.12	.16	.06	–.03	–.03	.67	.75	–									
10 GPA (t1)	.04	.03	.02	.04	–.04	.35	.10	.13	.13	–								
11 GPA (t2)	.04	.03	.04	.03	–.02	.39	.11	.14	.16	.87	–							
12 GPA (t3)	.04	.04	.05	.02	–.02	.41	.09	.16	.17	.83	.94	–						
13 Quality of instruction (t1)	.10	.06	.02	.08	.03	–.06	.34	.24	.22	.08	.07	.05	–					
14 Quality of instruction (t2)	.07	.00	.00	.04	.03	–.05	.22	.31	.23	.07	.09	.06	.56	–				
15 Quality of instruction (t3)	.09	.03	.00	.07	.04	–.07	.19	.24	.28	.03	.05	.04	.50	.62	–			
16 Perceived support (t1)	.07	.03	.01	.05	–.01	–.03	.21	.14	.13	.08	.08	.06	.50	.34	.32	–		
17 Perceived support (t2)	.10	.02	.04	.07	–.01	–.03	.17	.23	.18	.09	.09	.06	.36	.51	.37	.47	–	
18 Perceived support (t3)	.05	.03	.03	.03	.04	–.01	.12	.14	.19	.07	.08	.07	.34	.37	.48	.43	.49	–

t1 = first academic year, t2 = second academic year, and t3 = third academic year. Quality of instruction is same as perceived quality of instruction. All performance in study program is seen as GPA (Grade Point Average)

Table 5 Descriptive results for subject interest by academic year and gender

	Female			Male		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
Academic year 1	2143	3.62	.68	1623	3.79	.66
Academic year 2	2769	3.48	.76	2059	3.71	.71
Academic year 3	2017	3.45	.77	1504	3.66	.76

Table 6 Descriptive results of subject interest by academic year and academic discipline

	Economics			Engineering			Social Work		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
Academic year 1	2148	3.60	.70	1195	3.79	.64	424	3.92	.60
Academic year 2	2769	3.46	.77	1432	3.68	.70	627	3.84	.63
Academic year 3	2044	3.41	.78	1004	3.68	.76	473	3.82	.64

increase in perceived support corresponds to a 0.068 unit increase in subject interest. Similarly, a one-unit increase in perceived quality of instruction corresponds to a 0.276 unit increase in subject interest. Cognitive-rational factors of performance, specifically GPA ($B=0.143$, $p<0.001$) and university entrance score ($B=-0.053$, $p=0.001$), showed significant effects. Male students scored higher than female students ($B=-0.234$, $p<0.001$). Older students exhibited higher values for subject interest ($B=0.008$, $p=0.006$), but subject interest decreased over time ($B=-0.003$, $p<0.001$).

Model 3 further integrated variables concerning the lecturers' attitude toward academic success and academic discipline. We observed a modest improvement in model fit between model 2 ($R^2=0.721$; $AIC=20,401$; $BIC=20,519$) and model 3 ($R^2=0.724$; $AIC=20,394$; $BIC=20,720$) by a likelihood ratio test ($\chi^2(28)=62.41$, $p<0.001$). The lecturers' attitude toward academic success indicators showed no significant association with subject interest. However, students from the academic discipline Engineering exhibited higher subject interest than students from Economics ($B=0.215$, $p=0.005$). Similarly, students from Social Work showed higher subject interest than students from Economics ($B=0.362$, $p=0.007$). The coefficients of variables integrated in model 2 changed only slightly in model 3.

In model 4, we finally incorporated interaction effects of time in study program and gender, as well as time in the study program and academic discipline. A likelihood ratio test between model 3 ($R^2=0.724$; $AIC=20,394$; $BIC=20,720$) and model 4 ($R^2=0.725$; $AIC=20,375$; $BIC=20,723$) yields evidence of a small improvement in model fit ($\chi^2(3)=24.73$, $p<0.001$). A significant interaction effect was found between time in study program and gender ($B=-0.003$, $p=0.001$), time in the study program and academic discipline Engineering compared to Economics ($B=0.002$, $p=0.026$), as well as time in study program and academic discipline Social Work compared to Economics ($B=0.004$, $p=0.012$). These interactions were visualized (see Figs. 1, 2, 3). The coefficients for other variables showed little difference when comparing the same variable in model 3 and model 4 (see Table 7).

The development of trajectories resulting from the interaction between time in the study program and the academic discipline of Engineering, as compared to Economics, is visualized in Fig. 1. Initially, students in Engineering exhibited higher scores for

Table 7 Results of the three-level growth curve modelling investigating predictors of subject interest

	Model 1			Model 2			Model 3			Model 4		
	B	SE	p	B	SE	p	B	SE	p	B	SE	p
Lecturer attitude to academic success (level 3; ICC = .050)												
High grades							0.037	.111	.743	0.030	.107	.790
Low dropout rate							0.038	.062	.557	0.053	.059	.394
Graduates with professional skills							-0.097	.270	.726	-0.092	.259	.733
High satisfaction of students							0.003	.093	.979	-0.009	.095	.922
Preparation for labor market							0.066	.123	.601	0.051	.122	.682
Academic discipline: Engineering (Ref. Economics)							0.215	.058	.005	0.179	.058	.017
Academic discipline: Social Work (Ref. Economics)							0.362	.109	.007	0.282	.108	.021
Time invariant variables of students (Level 2; ICC = .712)												
University entrance score				-0.053	.016	.001	-0.051	.016	.002	-0.049	.016	.002
Gender: female (ref. male)				-0.234	.018	<.001	-0.226	.018	<.001	-0.167	.026	<.001
Time variant variables of students (level 1)												
Perceived support				0.068	.008	<.001	0.068	.008	<.001	0.067	.008	<.001
Perceived quality of instruction				0.276	.011	<.001	0.274	.011	<.001	0.276	.011	<.001
Grade Point Average				0.143	.014	<.001	0.142	.014	<.001	0.139	.014	<.001
Age				0.008	.003	.006	0.007	.003	.014	0.007	.003	.014
Duration in study program (months)				-0.003	.001	<.001	-0.003	.001	<.001	-0.002	.001	.012
Duration in study program × Female										-0.003	.001	.001
Duration in study program × Engineering (Ref. Economics)										0.002	.001	.026
Duration in study program × Social Work (Ref. Economics)										0.004	.001	.012
Intercept	3.621	.036	<.001	2.104	.110	<.001	1.990	1.211	.132	2.034	1.115	.126
R ²				.721			.724				.725	
AIC				20,401			20,394			20,375		
BIC				20,519			20,720			20,723		

Table 7 (continued)

	Model 1			Model 2			Model 3			Model 4		
	B	SE	p	B	SE	p	B	SE	p	B	SE	p
Variances												
Intercept (Level 3)		.361			.023				<.001			<.001
Intercept (Level 2)		.026										
University entrance score (Intercept)				.145		.058						.102
University entrance score (Slope)				<.001		<.001						<.001
Gender (Intercept)				.145		.048						.083
Gender (Slope)				.098		.073						.246
Engineering (Intercept)				.145		.103						.054
Engineering (Slope)				.098		.033						.036
Social Work (Intercept)						.141						.114
Social Work (Slope)						.094						.153
Preparation for labor market (Intercept)						.437						.246
Preparation for labor market (Slope)						.026						.015
High satisfaction of students (Intercept)						.199						.483
High satisfaction of students (Slope)						.010						.028
Graduates with professional skills (Intercept)						.361						.009
Graduates with professional skills (Slope)						.016						<.001
Low dropout rate (Intercept)						.005						<.001
Low dropout rate (Slope)						.001						<.001
High grades (Intercept)						.003						<.001
High grades (Slope)						<.001						<.001
Residuals		.157		.146		.146						.145

Models: N (level 1) = 12,116, N (level 2) = 5491, N (level 3) = 22. Presented are unstandardized regression weights with their standard errors and two-tailed p values. ICC intraclass correlation coefficients, $Variances$ variance components, AIC Akaike information criterion, BIC Bayesian information criterion

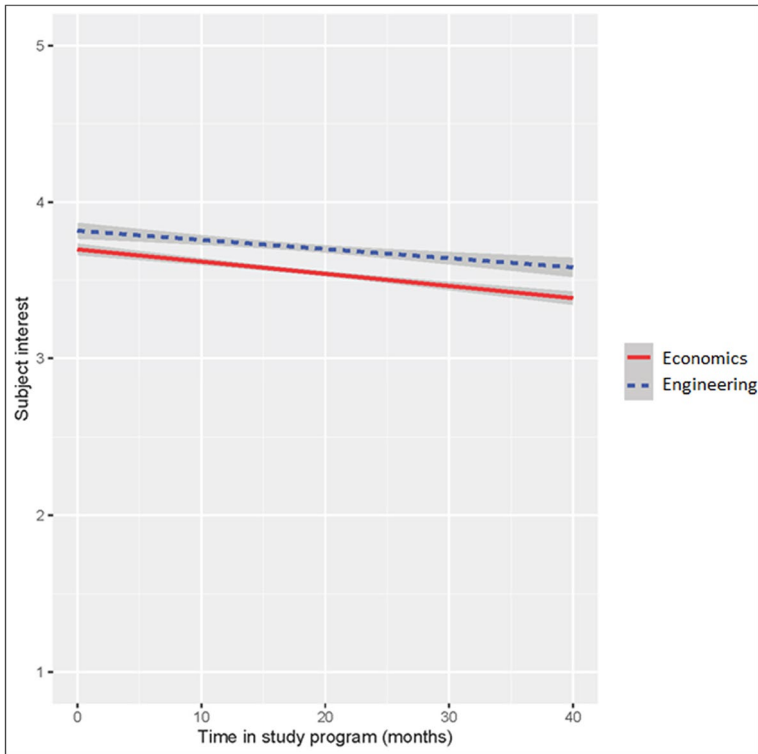


Fig. 1 Growth curve of subject interest from academic discipline Economics ($n=3147$) comparing to Engineering ($n=1655$) in study program based on model 4 (in Table 7). Note: The hatched area in the plot shows confidence interval (CI) of 95%. Scale of subject interest range from 1 (=strongly disagree) to 5 (=strongly agree)

subject interest than those in Economics. It can be seen in Fig. 1 that subject interest in the academic discipline of Economics decreases more rapidly than in Engineering.

Similar findings are illustrated in Fig. 2 regarding the visualization of the interaction term “time in study program” and academic discipline Economics compared to Social Work. Students in the academic discipline of Social Work scored higher than those in Economics. Furthermore, interest in Economics appears to decline more rapidly than in Social Work.

The interaction effect in Fig. 3 visualizes the between subject interest of female students compared to male students over time in the study program. Initially, the figure illustrates that male students scored higher on subject interest than female students. However, as time progressed, the differences increased, with female students exhibiting a faster decline than male students.

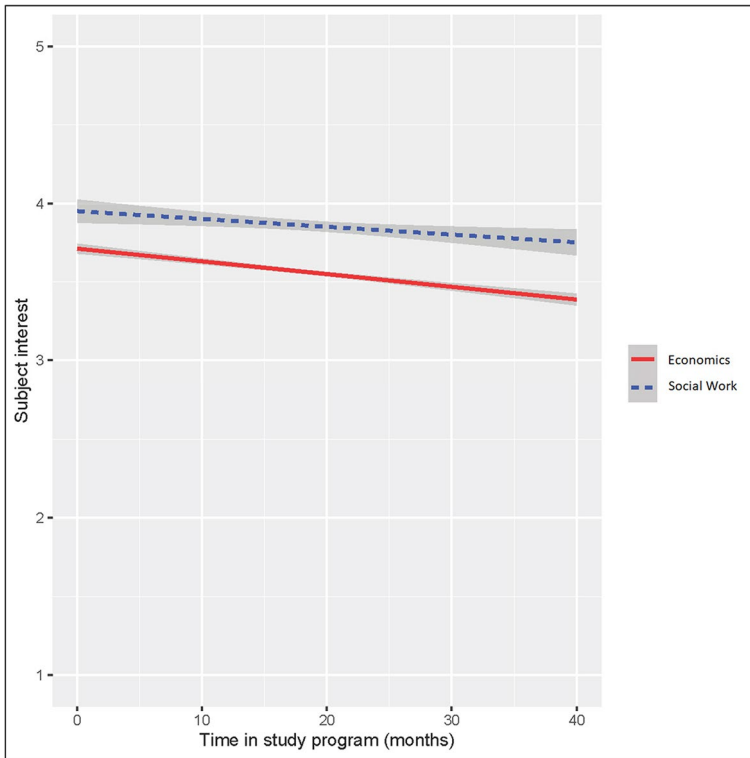


Fig. 2 Growth curve of subject interest from academic discipline Economics ($n=3147$) comparing to Social Work ($n=689$) in study program based on model 4 (in Table 7). Note: The hatched area in the plot shows confidence interval (CI) of 95%. Scale of subject interest range from 1 (=strongly disagree) to 5 (=strongly agree)

Discussion

In this longitudinal study, we analyzed the factors contributing to the development of the trajectories of subject interest. The results showed that individual characteristics at the student level are associated with interest development. In contrast, the factors at lecturer level indicated no significant prediction on interest development.

The results provide empirical evidence supporting hypotheses 1a and 1b. That is, higher performance before and during the study program was related to subject interest. This is consistent with the assumptions of the theoretical framework of the dual regulation system and the related components of the cognitive rational factor. While higher performance in the study program showed an expected positive association, performance before the study program showed an unexpected negative association. Possibly, students with high performance before study program were underchallenged, which may have caused this association. We also found a small positive correlation between performance and interest, which is in line with previous studies (Jansen et al., 2016; Robinson et al., 2019; Rotgans & Schmidt, 2011; Scherrer et al., 2020; Schiefele et al., 1993; van Maurice et al., 2014). Again, it must be noted that there is a debate about the causal direction of this association, i.e., whether interest influences performance or vice versa.

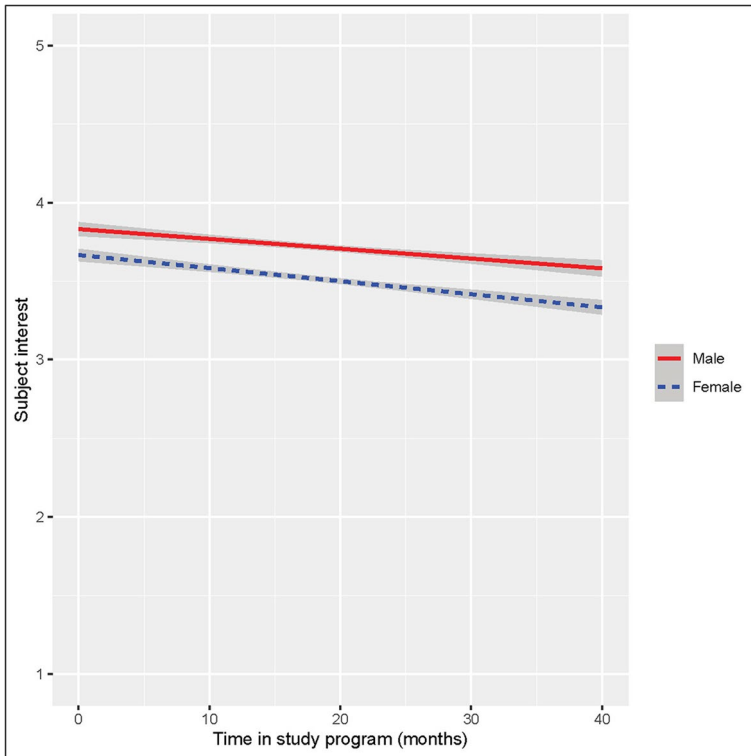


Fig. 3 Growth curve of subject interest from female students ($n=3123$) comparing to male students ($n=2368$) in study program based on model 4 (in Table 7). Note: The hatched area in the plot shows confidence interval (CI) of 95%. Scale of subject interest range from 1 (=strongly disagree) to 5 (=strongly agree)

Our results support the importance of the emotional subsystem in the dual regulation system of POI, as indicated by positive empirical associations of perceived quality of instruction (hypothesis 1c) as well as perceived support (hypothesis 1d) on subject interest. Other researchers had already shown such associations, so we were able to replicate the results and further confirm the theoretical assumptions of POI (Dietrich et al., 2015; Lazarides et al., 2019; Ruzek et al., 2016; Wentzel & Miele, 2016; Wild, 2023).

We also found differences in gender, confirming hypothesis 1e. Our research showed that male students reported higher subject interest compared to female students. This emphasizes, once again, the effect of factors at the student level. Theoretically, gender differences can be explained by social role theory (Eagly & Wood, 2012), which assumes that people fulfill societal functions according to role attributions and internalize them as they grow up (Ifegbesan & Azeez, 2024). Gender roles encompass social norms of behavior expected of individuals based on gender within a given culture, including traditional responsibilities and tasks typically assigned to men, women, boys, and girls (Ifegbesan & Azeez, 2024). Similar findings of male students outperforming females in subject interest have also been observed in STEM academic disciplines in higher education (Benden & Lauermaun, 2022; Frenzel et al., 2010; Robinson et al., 2019; Stolk et al., 2021). However, these findings were difficult to explain, as gender differences seem to depend on specific

subpopulations. For example, female students scored higher in other academic disciplines such as Economics (Arnold & Rowaan, 2014).

In analyzing hypothesis 2, it was assumed that the environment is crucial for the development of subject interest, which underlines the importance of POI. We were able to confirm hypothesis 2b, indicating that subject interest varies across different academic disciplines. The relationship between academic discipline and student behavior has been widely discussed (Elchardus & Spruyt, 2009). Theoretical assumptions according to Biglan (1973, p. 195) list distinguishing criteria between three dimensions: (i) the existence of a paradigm, (ii) concern with the application, and (iii) concern with the life system. A more detailed analysis identifies three additional dimensions characterized by contrasting terms: hard and soft, pure and applied, life and non-life disciplines. The description of the hard-soft dimension is related to the domain in which the topic is related to the core theory. Pure and applied refers to the application of learning content, and finally the life and non-life dimension differentiates between human and biological categorizations (Biglan, 1973; Goel, 2010; Zadavec & Kočar, 2023). As argued by Doberneck and Schweitzer (2017), Biglan classified academic disciplines of Economics as “applied, soft, and non-life,” Engineering as “applied, hard and non-life,” and Social Work as “applied, soft, and life.” This classification suggests potential differences between these academic disciplines. Students in the academic discipline of Engineering and Social Work scored higher in our research than students in Economics. The low interest scores of Economics students were not surprising, as similar findings were presented by Lullaku and Bërxulli (2017). In contrast, hypothesis 2a was rejected, because none of the five attitudes toward academic success were associated with subject interest. Possible reasons for this result could stem from the particular type of students involved in cooperative education especially considering that these students often rotate between university and company, have contracts with companies, and emphasize practical orientation in their program. Furthermore, the 210 ECTS in the 3 years in this very standardized program could have an association on the results in our research. Another reason could be that the lecturers had a high level of practical experience in companies, which is a prerequisite for being a professor at this type of higher education institution.

Finally, we were also able to confirm hypothesis 3, which postulated a decline in subject interest during the study program. Numerous studies have shown this empirical association (Benden & Lauermaun, 2022; Brahm et al., 2017). Consequently, hypothesis 4 explored the issue of declining subject interest in more detail. We found an interaction effect of time and gender (hypothesis 4a) as well as time and academic discipline (hypothesis 4b). Female students showed a greater decline in subject interest than male students. In the academic discipline Economics, the subject interest declined faster than in Engineering and Social Work.

Our study has several limitations. Firstly, the perceived support and perceived quality of instruction were assessed in a very general manner. Additionally, the perceived quality of instruction may vary from course to course, and the reliability of perceived support was considered problematic, with $\omega \leq 0.76$ across different academic years. Generalizing our results to all university students was challenging because we had only collected data from cooperative students, where a contract with a company is a requirement to study in that program (Deuer et al., 2020). Another limitation of our study was that the database of our results was obtained from only one university located in one federal state of Germany. Unfortunately, we could only use the binary gender variable and consider only three academic disciplines in our research. Furthermore, we employed a large sample size in our research, which is generally a strength of the study. However, it is important to note that in

analyses with large samples, even small and practically irrelevant effects can become statistically significant. Finally, the proportions of students in different academic disciplines were not equal in our study.

We were able to identify variables that counteract interest decline, such as perceived support and perceived quality of instruction, which can be used to model interest processes. Our data were not biased by the COVID-19 pandemic and were less subjective because we used objective data from the university administration. This procedure reduced measurement error, questionnaire length, and social desirability in our research. Finally, we tested our hypothesis on a subpopulation, here cooperative students, a group of students that is growing in Germany (Hofmann, 2023), and research on this population is rare as well as “selecting the best” students through practice (Weich et al., 2017).

Our findings have important practical implications. Coaching programs could be implemented to support university students and mitigate the decline in interest, which is already partially integrated into fitness programs for university students (Gaesser et al., 2020) or in teacher programs (Unterbrink et al., 2012). Another possibility is to use the results for online self-assessments (Ćukušić et al., 2014), for example, to reflect on learning, which is considered a prerequisite for higher interest in theoretical frameworks as suggested, for example, by Schmitz and Perels (2011). It is also possible to strengthen the didactic skills of university lecturers through advanced training (Biggs & Tang, 2011). This could improve the perceived quality of instruction and prevent the decline of student interest.

Future research should test the robustness of our results. Researchers should shed light on the development of interest, but research on other motivational variables should not be forgotten, such as expectations of success and the subject task values of attainment value and utility value (Eccles & Wigfield, 2020), and in particular, the component relative costs (Flake et al., 2015). The analysis of interest development in other groups in higher education, such as PhD students (Jaksztat et al., 2021) or lecturers (Daumiller et al., 2020), is considered important because it may explain the reputation of the university or the work performance of employees. Another interesting question is how different interest trajectories of university students affect their subsequent working lives, for example, in terms of career advancement or salary history.

Conclusion

In summary, this study showed that factors at the student level were associated with the development of subject interest, whereas factors at the lecturer level were not related to subject interest. Future research should examine the robustness of our findings and address additional motivational aspects. Such research is essential to counteract the decline in interest and to explain academic success.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10212-024-00913-7>.

Author contribution OKH and SW developed the research questions. OKH and SW discussed and executed the research design. SW performed the data analysis and was contributed in data collection. SW wrote the first draft of the manuscript. OKH revised the first manuscript version. All authors read and approved the final manuscript.

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Data Availability Data is available. Please contact the corresponding author.

Code availability Syntax is available. Please contact the corresponding author.

Declarations

Informed consent Informed consent was obtained from all students who participated in the study prior to their completion of the research questionnaires.

Ethics statement All procedures of the conducted study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by Baden-Wuerttemberg Cooperative State University (July 8 2015).

Conflict of interest The authors declare no competing interests.

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Current themes of research:

Empirical educational research. Methods of empirical social research. Research in higher education. Dropout.

Most relevant publications in the field of Psychology of Education:

- Wild, S., & Neef, C. (2023). Analyzing the associations between motivation and academic performance via the mediator variables of specific mathematic cognitive learning strategies in different subject domains of higher education. *International Journal of STEM Education*, 10, 1–14. <https://doi.org/10.1186/s40594-023-00423-w>
- Wild, S., & Grassinger, R. (2023). The importance of achievement motivation, difficulties in self-regulation, and quality of instruction in students' university drop out process. *British Journal of Educational Psychology*, 93(3), 758–772. <https://doi.org/10.1111/bjep.12590>

- Wild, S., Rahn, S., & Meyer, T. (2023). The relevance of basic psychological needs and subject interest as explanatory variables for student dropout in higher education — A German case study using the example of a cooperative education program. *European Journal of Psychology of Education*. Advance online publication: <https://doi.org/10.1007/s10212-022-00671-4>
- Wild, S., Rahn, S., & Meyer, T. (2023). Comparing long-term trajectories in subject interest among non-traditional students and traditional students – An example from a cooperative higher education programme in Germany. *Learning and Individual Differences*, 101, 102250. <https://doi.org/10.1016/j.lindif.2022.102250>
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Current themes of research:

Development of educational assessments. Latent variable models in educational measurement (cognitive diagnostic models, item-response-models, structural equation modelling). Assessing and modeling professional teacher competence (in particular the subject-unspecific educational knowledge). Assessing and modeling of digital and ICT-related skills among students.

Most relevant publications in the field of Psychology of Education:

- Holzberger, D., Maurer, C., Kunina-Habenicht, O., & Kunter, M. (2021). Ready to teach? A profile analysis of cognitive and motivational-affective teacher characteristics at the end of pre-service teacher education and the long-term effects on occupational well-being. *Teaching and Teacher Education*, 100. <https://doi.org/10.1016/j.tate.2021.103285>
- Kunina-Habenicht, O., & Goldhammer, F. (2020). ICT engagement: A new construct and its assessment in PISA 2015. *Large-scale Assessments in Education*, 8 (6). <https://doi.org/10.1186/s40536-020-00084-z>
- Kunina-Habenicht, O., Rupp, A. A., & Wilhelm, O. (2017). Incremental validity of multi-dimensional proficiency scores from diagnostic classification models: An illustration for elementary school mathematics. *International Journal of Testing*, 17(4), 277–301. <https://doi.org/10.1080/15305058.2017.1291517>
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