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The developmental trajectories of teacher autonomy support and adolescent mental well-being and academic stress

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Abstract
This study investigated the developmental impact of teacher autonomy support on changes in students' mental well-being and academic stress throughout upper secondary school. The sample consisted of 1453 Norwegian students (baseline $M_{age} = 17.00$; 60.6% girls; 80.9% Norwegian-born). The unconditional latent growth curve model results showed that perceived teacher autonomy support and mental well-being decreased during the three-year-long education. Academic stress, on the other hand, increased during this period. Findings from the parallel process latent growth curve model indicated that the initial status and change in teacher autonomy support were positively and negatively related to the initial levels and trajectories of mental well-being and academic stress, respectively. Girls experienced a higher level of academic stress and lower mental well-being and teacher autonomy support at the beginning of upper secondary school. Students with a higher socioeconomic status reported higher initial mental well-being and teacher autonomy support than others but also a more rapid decline in teacher autonomy support throughout upper secondary school. This study provides new insights into academic, psychological, and affective processes and their interrelationships during upper secondary school.

Keywords Teacher autonomy support · Mental well-being · Academic stress · Parallel process latent growth curve model

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1 Introduction

Outside of sleeping, adolescents spend most of their time in school—learning, socializing, shaping themselves, and preparing for their future (Eccles & Roeser, 2011). Although many are able to cope and even thrive throughout the educational transitions occurring in adolescence, some experience adverse socio-emotional disruptions and academic maladjustment (Benner, 2011; Eccles & Roeser, 2009). During upper secondary education (grades 11–13), students experience a host of developmental challenges, such as environmental and academic stressors, that might affect their wellness and functioning. During these formative years, there is an increase in normative testing, pressure to perform well in school and attend all classes, negative teacher interactions, concerns about the future, and emerging adult responsibilities (Byrne et al., 2007). After future goals, upper secondary students report grades, homework, own expectations about school, and pressure from parents/responsibilities as the most frequently experienced stressors (Anda et al., 2000). Similarly, a performance-oriented goal structure in the classroom might be a risk factor in adolescents' development of coping beliefs and experiences of school stress (Haugan et al., 2021). The increase in environmental and educational stressors can adversely affect adolescents' physical (Karvonen et al., 2005) and psychological (Grant et al., 2014) health.

Yet, the experience of autonomy support from teachers may reduce the impact of developmental instabilities in students and even promote positive developmental aspects such as autonomous motivation, wellness, and psychological growth (Ryan & Deci, 2017). Autonomy-supportive teachers take students´ perspective by providing students with relevant choices and meaningful rationales, acknowledge negative affect, and minimize pressure and demands (Reeve & Cheon, 2021), facilitating further satisfaction of the basic psychological needs for autonomy, competence, and relatedness (Ryan & Deci, 2017). However, how the developmental changes in teacher autonomy support and student well-being are related is a nascent research area (e.g., Kleinkorres et al., 2023), and little is known about how changes in teacher autonomy support impact the development of academic stress coping during an upper secondary education. Thus, evidence on the longitudinal effects of teachers´ autonomy support during adolescent school years on wellness and stress throughout this developmental period is somewhat lacking. This study aims to fill this knowledge gap in the literature. The study builds on the theoretical assumptions of self-determination theory. It tests a parallel process latent growth curve model with directional effects from teacher autonomy support to student mental well-being and academic stress among a Norwegian upper secondary school sample. Our study might have implications for educational practices and provide important knowledge on developmental changes in perceptions of the learning environment and how they relate to psychological, affective, and academic growth in middle to late adolescence.

1.1 Self-determination theory and teacher autonomy support

According to Self-Determination Theory (SDT), there are three universal basic psychological needs for autonomy, competence, and relatedness (Deci & Ryan, 1985). Autonomy concerns people's ability to act with feelings of volition and willingness (DeCharms, 1968). Competence refers to perceiving oneself as feeling effective in the interaction with one's environment through an expression of personal capacities (Deci & Ryan, 1980; White, 1959). Lastly, relatedness concerns feelings of being connected with others and experiencing a sense of belonging, wherein you care about others, and they care about you in return (Baumeister & Leary, 1995; Deci & Ryan, 2000). Satisfaction of these needs brings about positive developmental qualities such as autonomous motivations (behaviors done out of enjoyment and interest or value), psychological wellness, and social adjustment (Soenens & Vansteenkiste, 2023). In contrast, need thwarting and frustration (i.e., feeling one's basic needs are being obstructed or actively frustrated) are associated with controlled motivation (behaviors done out of pressure or coercion) and developmental harm such as depression (Chen et al., 2015), stress, and somatic anxiety (Tindall & Curtis, 2019). Notably, the effect of psychological need satisfaction on motivation and wellness has been shown to be invariant across genders, cultures, and developmental stages (Chen et al., 2015).

A central tenet within SDT is that psychological need satisfaction depends on contextual support (Ryan & Deci, 2017). When the social context, such as teachers, leaders, parents, or other authority figures, are autonomy-supportive, the individual will experience satisfaction of the psychological needs (Ryan & Deci, 2017). This link has been found in several contexts relevant to adolescents, such as education (Sheldon & Krieger, 2007) and sports (Bartholomew et al., 2011a, 2011b). Students spend much of their awake time in schools, making processes occurring in the learning environment focal for student behavior, mental health, and educational attainment (Rutter, 1980). In the classroom, teachers are in a unique position to facilitate a positive learning climate and promote students' motivation, wellness, and growth (Chirkov & Ryan, 2001; Deci et al., 1991; Reeve, 2002) and prevent the development of mental health issues such as depression (Zhang et al., 2022) and academic stress (Zheng et al., 2020).

1.2 The associations between teacher autonomy support, mental well-being, and academic stress

Mental well-being is defined as different aspects of positive mental health (Tennant et al., 2007) and has been declared a 'foundation for effective functioning for individuals and populations' by the World Health Organisation (WHO, 2004). Mental well-being refers to the experience of positive affect, a high degree of life satisfaction, flourishing, and functioning well in life (Deci & Ryan, 2008). In other words, the concept encompasses hedonistic feelings (i.e., happiness and life satisfaction: Diener et al., 1985; Huppert et al., 2009), as well as eudaimonia (i.e., living towards a purpose,

satisfying basic psychological needs, and doing well: Ryan & Deci, 2011; Ryff, 1989; Vittersø et al., 2010). Promoting mental well-being is fundamentally connected to human rights and equity (WHO, 2004) and constitutes a key ambition in Norway's core curriculum of values and principles in primary and secondary education (Ministry of Education & Research, 2017).

Teachers in secondary school are expected to foster students' health, well-being, and learning by facilitating a safe and supportive learning environment. These expectations broadly align with autonomy-supportive teaching practices, such as acknowledging others' perspectives, encouraging initiative, offering choices, providing appropriate information, and reducing pressure and control (Rouse et al., 2011). The emerging literature on the longitudinal effect of teacher autonomy support indicates that autonomy-supportive teaching is intricately related to agentic engagement (Jang et al., 2024; for an overview, see Yang et al., 2022). Furthermore, teacher autonomy support might buffer the development of depression (Zhang et al., 2022) and reduce academic pressure (Ruzek & Schenke, 2019) and peer victimization (Cheon et al., 2023). Autonomy-supportive teaching is widely regarded as a fundamental promoting factor in students' deep learning (Kaplan, 2018) and learning strategies (Brandisauskiene et al., 2023).

Negative stress is an unpleasant bodily arousal accompanied by adverse feelings and cognitions (Lazarus & Folkman, 1984). If people lack the resources to handle (i.e., cope with) a challenging or threatening situation, negative stress arises (Lazarus, 1966; Sarafino & Smith, 2022). However, threatening situations, characterized by negative stress responses, can be transformed into benign-positive or irrelevant circumstances based on an individual's available resources (Lazarus & Folkman, 1984). Because basic need satisfaction is related to vitality and autonomous motivation (Ryan & Deci, 2000), an increase in autonomy support might transform stressors that were previously perceived as threats into challenges or something benign because of productive stress coping (Ryan & Frederick, 1997) and feelings of relevance and manageability, resulting in positive stress (eustress: Selye, 1974; Travis et al., 2020). For instance, controlled motivation is associated with anxiety and negative coping strategies, whereas positive coping strategies are related to autonomous motivation (Ryan & Connell, 1989). In other words, teachers might facilitate students' ability to handle the demands of school- and homework by promoting and facilitating autonomy, thus reducing academic stress and increasing well-being. Additionally, teachers who create supportive classrooms characterized by respect, encouragement, and understanding (i.e., autonomy-supportive behaviors), as opposed to non-supportive ones, enable children to regulate their own stress levels throughout the school week (Ahnert et al., 2012). In a similar vein, one study found that teacher autonomy support was negatively and indirectly associated with school burnout (Ljubin-Golub et al., 2020), a severe form of school-related stress.

1.3 Changes in teacher autonomy support, mental well-being, and academic stress

Recent findings imply that life satisfaction, mental well-being, and self-rated health have declined over time in 15-year-olds (Cosma et al., 2023). School stress has also increased in the same age group (Högberg, 2021). Increasing schoolwork pressure

and evaluations have been considered explanatory factors in the adverse secular trends in mental well-being and school-related stress (Cosma et al., 2020; Högberg et al., 2021). Increased demands to choose academic and professional paths during upper secondary school surrounds students with a surge of academic pressure during this period (Deb et al., 2015; Song et al., 2015). Indeed, secondary school students are often faced with various hassles and demands associated with their academic functioning (Dewald et al., 2014; Pascoe et al., 2020) and subsequently feel stressed (Leonard et al., 2015; McGraw et al., 2008; Moeller et al., 2020).

Perhaps unsurprisingly, research indicates that well-being decreases throughout adolescence across different cultures (Herke et al., 2019; Kleinkorres et al., 2023; O'Donnell et al., 2022; Shek & Lin, 2017; Zhu & Shek, 2021). Researchers have put forth many contextual and individual factors as potential explanations for this negative developmental change, such as the school environment (Boen et al., 2020) and teacher autonomy support (Kleinkorres et al., 2023), parenting style (Zhu & Shek, 2021), relational and spiritual qualities (Shek & Liang, 2018), boredom (Schwartze et al., 2021), substance use (O'Donnell et al., 2022), school transitions (Conley et al., 2020), racism (Astell-Burt et al., 2012), and gender (Petts, 2014). In addition to increased academic stressors and unfavorable developmental changes in mental well-being during adolescence, recent studies show that teachers´ autonomy support decreases throughout primary and secondary education (Bardach et al., 2023; Kleinkorres et al., 2023). There might be adverse trajectories of teacher autonomy support, mental well-being, and academic stress during upper secondary school because there is a more intense performance-oriented climate in this period compared to primary school (Maehr & Zusho, 2009), resulting in higher achievement pressure exerted by the environment around students (Song et al., 2015). Moreover, secondary school students may experience their teachers as decreasingly supportive due to a growing need for autonomy (Eccles & Roeser, 2009).

Kleinkorres et al. (2023) suggested that a negative development of well-being throughout education could be related to the environment's inability to satisfy young people's psychological needs, such as non-supportive teachers. The study found that both teacher autonomy support and well-being (i.e., satisfaction with school, enjoyment of school, and self-rated health) declined from grade 5 to 9 and that these trajectories were positively associated (Kleinkorres et al., 2023). In a similar vein, Obermeier et al. (2022) found that a positive instructional climate quality (e.g., "the teacher is friendly to me") in lower secondary school had a positive impact on the development of students' scholastic well-being. We expand this research to an upper secondary school setting (grade 11–13), where teachers have a slightly different role than during lower secondary and particularly primary school, and investigate academic maladjustment (i.e., academic stress). During primary and lower secondary school in Norway, the students have few teachers covering many subjects. In contrast, teachers generally cover one or two subjects in upper secondary school. Thus, teacher-student interactions are shorter and scarcer during upper secondary school (Tobbell & O'Donnell, 2013). However, teacher autonomy support is found to be important for students' motivation, perceived competence, and academic functioning in Norwegian higher education (e.g., Jeno et al., 2021; Johansen et al., 2023), where students have even briefer interactions with their instructors compared to

upper secondary school. Hence, investigating the effects of teacher autonomy support on students' mental well-being and academic stress, despite relatively few interactions, is potentially important for upper secondary school practices.

1.4 Study aims

The main aim of this study is to further our understanding of how changes in teacher autonomy support predict students' development of academic stress and psychological and affective functioning in middle to late adolescence. Autonomy support is important not only to satisfy the need for autonomy but also the needs for competence and relatedness (Ryan & Solky, 1996). Autonomy need satisfaction is imperative to experience high-quality motivation while, for instance, competence need satisfaction is not enough (Ryan & Moller, 2017). To illustrate, Hornstra et al. (2021) found that teachers' high levels of structure and involvement (i.e., competence and relatedness support) could not compensate for a lack of teacher autonomy support concerning academic adjustment, such as motivation and achievement. We use SDT as a theoretical framework to examine the impact of changes in teacher autonomy support on the development of students' mental well-being and academic stress during upper secondary education in Norway.

We include sex, socioeconomic status, and immigration background as control variables because they have been found to impact the outcome variables (i.e., mental well-being and academic stress) in previous studies. For instance, research indicates that, compared to boys, girls report a less favorable development of mental well-being (Yoon et al., 2023) and academic stress (Kristensen et al., 2023) during adolescence. A similar development is found in a secular trend perspective, wherein young girls constitute a vulnerable group in mental health indicators (Cosma et al., 2023) and school stress (Högberg et al., 2020), with progressively worsening levels over time. Adolescents from families with higher affluence and parental education report greater mental well-being (Cosma et al., 2023) and lower perceived stress (Finkelstein et al., 2007) than others. Lastly, studies imply that immigrant students in secondary school have a higher prevalence of psychological problems (Oppedal & Røysamb, 2004) and are more at risk of experiencing psychological distress at school (Alivernini et al., 2020) than non-immigrants.

Based on previous research and the theoretical assumptions of SDT, we hypothesized the following:

Hypothesis 1 Teacher autonomy support and mental well-being decrease, while academic stress increases during upper secondary school.

Hypothesis 2 Teacher autonomy support is positively and negatively, respectively, related to mental well-being and academic stress.

2 Methods

2.1 Procedure and participants

This study used data from the COMPLETE study (Larsen et al., 2018), a school-based intervention project designed to improve the psychosocial learning environment and increase completion rates in upper secondary schools. Seventeen schools participated in the study, 12 received intervention measures, and five served as the control group. The project collected data from a cohort of students from the beginning of upper secondary school (grade 11) to the end (grade 13). The first measurement occasion (T1) was in March 2017, followed by data collections in March 2018 (T2) and 2019 (T3). The data measures included in this study were similar across all schools. Thus, we included intervention as a control variable. The intervention did not significantly affect the study's variables (please see Appendix B for details). Researchers physically collected survey data during school hours, and students who were absent but enrolled in school were asked to participate via SMS.

The participants in the present study were students who attended an academic study track in the COMPLETE project. A total of 1453 students responded throughout the study (T1 $n=1184$, T2 $n=949$, T3 $n=1016$), wherein 609 students participated at all three time points. The students' ages ranged from 16 to 25 years; most (94%) were 16 or 17 at T1 (baseline). Regarding sex, 39.4 percent ($n=572$) were boys, and 60.6 percent ($n=881$) were girls. Common in Norwegian upper secondary school, more girls attend an academic study track, while the majority of students in a vocational education and training program are boys. In total, 80.9 percent ($n=1088$; valid $\%=92.5$) reported they were Norwegian-born, 6.1 percent ($n=88$; valid $\%=7.5$) students had an immigration background (i.e., were born outside of Norway), and 19.1 percent ($n=277$) did not know where they were born or did not answer the question. National numbers from 2016 show that 12 percent of the Norwegian upper secondary school population were born outside of Norway (The Norwegian Directorate for Education & Training, 2017), while the present sample is slightly more homogenous, wherein almost eight percent had an immigration background. Concerning socioeconomic status, 0.7 percent ($n=10$; valid $\%=0.8$) said their family was 'not well off at all', 3.1 percent ($n=45$; valid $\%=3.8$) reported their family was 'not well off', 21 percent ($n=305$; valid $\%=26$) reported their family was 'moderately well off', 40.3 percent ($n=585$; valid $\%=49.8$) assessed their family as being 'well off', 15.8 percent ($n=230$; valid $\%=19.6$) reported their family was 'very well off,' and 19.1 percent ($n=278$) did not answer the question. The socioeconomic status in the present sample is similar to the prevalence in the Health Behaviour in School-aged Children Study (HBSC), which indicated that Norwegian adolescents generally have high family affluence (WHO, 2020).

2.2 Instruments

We measured *perceived teacher autonomy support* with five items from the short scale of the Learning Climate Questionnaire (LCQ: Black & Deci, 2000). The LCQ has proven reliable and valid in previous studies and has been used in similar

samples (Simon & Salanga, 2021; Yu et al., 2018). A sample indicator is 'I feel that my teachers provide me with choices and options'. The participant rated how much they agreed with the statements about their teachers on a Likert-scale ranging from 1 (*completely disagree*) to 5 (*completely agree*).

Mental well-being was measured using an adapted short version of the Warwick Edinburgh Mental Well-being Scale (WEMWBS: Clarke et al., 2011). The WEMWBS has, in previous studies, been shown to be valid and reliable in adolescent samples (McKay & Andretta, 2017; Ringdal et al., 2018). The short scale consists of seven indicators instead of 14 items in the full version. The participants rated how often they had 'felt and thought like this' during the last 14 days on a scale ranging from 1 (*not at all*) to 5 (*all the time*). In other words, high scores on this scale indicate higher mental well-being. A sample indicator is: 'I've been feeling optimistic about the future.'

Academic stress was measured using a single indicator from the 'Health Behaviour in School-Aged Children (HBSC)' study (Klinger et al., 2015; WHO, 2012). The question was, 'How stressed do you feel by the schoolwork you must do (both work during school hours and homework)?'. The response scale ranged from 1 (*not at all*) to 4 (*a lot*). Thus, high scores on this indicator suggest high school-related stress.

Control variables in the model were sex, socioeconomic status, immigration background, and intervention conditions. Information about participants' biological sex was obtained from registry data, wherein boys were coded as 0 and girls were coded as 1. Socioeconomic status was assessed using a single indicator of how well off the participants perceived their family to be (Iversen & Holsen, 2008). The participants rated their perceived family wealth on a scale ranging from 1 (*not well off at all*) to 5 (*very well off*). Regarding immigration background, the participants answered a question about where they were born. We coded the indicator as 0 (immigration background) and 1 (Norwegian-born). We included two dummy variables based on intervention conditions, coded as 0 (no intervention) and 1 (one of two interventions), similar to other studies controlling for possible intervention effects (e.g., Ringlever et al., 2013; Tak et al., 2017).

2.3 Analytical strategy

All analyses in this study were performed using SPSS version 28 (IBM, 2021) and Mplus version 8 (Muthén & Muthén, 1998–2017) with maximum likelihood estimation. Preliminary analyses included omega reliability tests, longitudinal confirmatory factor analyses, measurement invariance tests, bivariate correlations, and intraclass correlation coefficients (ICC) based on school belonging. Measurement invariance tests across time and sex were performed following the effects-coding approach (Little et al., 2006). The measurement invariance models have increasingly stricter constraints on the latent variables over time or groups. The configural model is freely estimated, the weak (metric) model has equality constraints on corresponding factor loadings, the strong (scalar) model has intercepts constrained on corresponding items, and the strict model includes constraints on similar residual error

variances (please see Table 3 for details on the measurement invariance results). Each step includes a comparison of model fit. Acceptable changes in model fit between models are based on the recommendations by Chen (2007): $\Delta CFI \leq 0.010$, $\Delta RMSEA \leq 0.015$, and $\Delta SRMR \leq 0.030$. The latent growth curve specifications retained the highest level of longitudinal measurement invariance.

The primary analysis comprised two steps. The first step was specifying unconditional latent growth curve models of teacher autonomy support, mental well-being, and academic stress. The second step tested a parallel process growth curve model, wherein the initial status and change in teacher autonomy support were specified as predictors of the students' initial levels and trajectories of mental well-being and academic stress. The unconditional growth curve models of teacher autonomy support, mental well-being, and academic stress were specified by creating an intercept and slope for each construct. The intercept factor loadings to corresponding latent variables were constrained to 1 and represent the initial status of the constructs. The slope factor loadings were specified to represent time, wherein the regression coefficients to the T1, T2, and T3 latent variables were, respectively, constrained to 0, 1, and 2. Lastly, all intercepts and slopes were included in the same model. The teacher autonomy support intercept was specified as a predictor of the intercepts and slopes of mental well-being and academic stress, and the teacher autonomy support slope was modeled as a predictor of the slopes of mental well-being and academic stress. The parallel process model was adjusted for sex, socioeconomic status, immigration background, and intervention conditions. To correct potential bias in the model's coefficients and standard errors, 'school' was used as a cluster variable in a type = complex analysis.

2.4 Missingness

Little's missing completely at random (MCAR) test for missing data (Little, 1988) across time indicated that missingness in the study's variables was completely at random ($\chi^2 = 3403.278$, $df = 3532$, $p = 0.675$). Therefore, missingness patterns were not further examined, and full information maximum likelihood (FIML) was used to handle potential construct-level missingness.

3 Results

The descriptive statistics of the study's variables are presented in Table 1, and the correlations between the study's variables are seen in Table 2. The scales of teacher autonomy support and mental well-being produced acceptable reliability values at all time points ($\omega > 0.90$). Regarding the associations within the constructs over time, the correlations were positive and moderate to large (Cohen, 1988). Teacher autonomy support was positively related to mental well-being on all measurement occasions with small to moderate effect sizes. In contrast, teacher autonomy support was negatively associated with academic stress, ranging from negligible to small in

Table 1 Descriptive statistics of the study's variables

	n	*ω*	Min–max	*M* (*SD*) / %	Skewness	Kurtosis
Perceived teacher autonomy support T1	1148	.90	1–5	3.67 (.79)	− .397	.491
Perceived teacher autonomy support T2	906	.91	1–5	3.65 (.81)	− .426	.518
Perceived teacher autonomy support T3	929	.93	1–5	3.60 (.85)	− .267	.034
Mental well-being T1	1123	.92	1–5	3.51 (.83)	− .535	.441
Mental well-being T2	893	.91	1–5	3.49 (.82)	− .387	.195
Mental well-being T3	989	.90	1–5	3.45 (.79)	− .307	.030
Academic stress T1	1153	–	1–4	2.71 (.92)	− .068	− .931
Academic stress T2	930	–	1–4	2.82 (.95)	− .192	− 1.027
Academic stress T3	953	–	1–4	3.12 (.86)	− .538	− .719
Sex (girls)	1453	–	0–1	60.6%	–	–
Immigration background (Norwegian-born)	1176	–	0–1	80.9%	–	–
Socioeconomic position	1175	–	1–5	3.84 (.81)	− .503	.407

ω omega reliability, *M* mean, *SD* standard deviation

effect sizes. Lastly, the correlations between mental well-being and academic stress were negative and negligible to small in effect sizes.

The ICC results indicated that the schools were not more similar than dissimilar concerning the study's constructs. The school-level ICC for teacher autonomy support, mental well-being, and academic stress was < 0.040 on all measurement occasions.

The results from the longitudinal measurement invariance tests are presented in Table 3. Teacher autonomy support and mental well-being achieved strict measurement invariance across time. Details on the measurement invariance tests across sexes are presented in Appendix A.

3.1 The developmental trajectories of teacher autonomy support, mental well-being, and academic stress

The results of the unconditional growth curve models of teacher autonomy support, mental well-being, and academic stress are presented in Table 4. The unconditional latent growth curve model of teacher autonomy support produced a good model fit: $\chi^2 = 407.448$, $df = 99$, RMSEA [95% CI] = 0.047 [0.042, 0.052], CFI = 0.972, and SRMR = 0.039. The results show that the students experienced significantly different teacher autonomy support in their first year of upper secondary school (intercept $\sigma^2 = 0.373$, $p < .001$). Further, the students reported that their perceived teacher autonomy support significantly decreased during upper secondary school (slope $M = -0.030$, $p < .05$) to varying degrees (slope $\sigma^2 = 0.086$, $p < .001$). The correlation between the teacher autonomy support intercept and slope was negative and significant ($r = -0.382$, $p < .001$), indicating that students who reported high initial levels of teacher autonomy support in upper secondary school experienced a more rapid decline in support during upper secondary school compared to others.

Table 2 Correlation matrix of perceived teacher autonomy support, mental well-being, and academic stress across time

	1	2	3	4	5	6	7	8	9	10	11	12
1. TAS T1	1.00											
2. TAS T2	.48**	1.00										
3. TAS T3	.36**	.49**	1.00									
4. MWB T1	.35**	.24**	.23**	1.00								
5. MWB T2	.29**	.38**	.34**	.53**	1.00							
6. MWB T3	.27**	.24**	.37**	.44**	.60**	1.00						
7. AS T1	−.14**	−.11**	−.08*	−.19**	−.09*	−.08*	1.00					
8. AS T2	−.03	−.12**	−.11**	−.13**	−.08*	−.09*	.55**	1.00				
9. AS T3	−.06	−.10*	−.12**	−.10**	−.05	−.18**	.49**	.53**	1.00			
10. Sex	−.12**	−.11**	−.15**	−.17**	−.15**	−.15**	.12**	.18**	.17**	1.00		
11. IB	−.00	−.00	−.05	.01	.03	.03	.06*	.03	.02	.02	1.00	
12. SES	.15**	.06	.04	.18**	.16**	.21**	−.07*	−.11**	−.06	−.11**	−.03	1.00

***$p < .001$, **$p < .01$, *$p < .05$. *TAS* perceived teacher autonomy support, *MWB* mental well-being, *AS* academic stress, *IB* immigration background, *SES* socioeconomic status

Table 3 Longitudinal measurement invariance of perceived teacher autonomy support and mental well-being

	χ^2	*df*	RMSEA [90%CI]	CFI	SRMR	ΔRMSEA	ΔCFI	ΔSRMR
Perceived teacher autonomy support								
Configural	315.009	72	.049 [.043, .054]	.978	.025			
Metric	324.848	80	.046 [.041, .052]	.977	.030	− .003	− .001	.005
Scalar	361.120	90	.046 [.041, .051]	.975	.034	.000	− .002	.004
Strict	**411.310**	**100**	**.047 [.042, .052]**	**.971**	**.037**	**.001**	**-.004**	**.003**
Mental well-being								
Configural	947.933	165	.057 [.054, .061]	.945	.033			
Metric	961.554	177	.056 [.052, .059]	.945	.036	− .001	.000	.003
Scalar	1011.330	191	.055 [.051, .058]	.942	.038	− .001	− .003	.002
Strict	**1041.264**	**205**	**.053 [.050, .056]**	**.941**	**.043**	**− .002**	**− .001**	**.005**

The accepted levels of invariance are enhanced in bold

The unconditional latent growth curve model of mental well-being produced a good model fit: $\chi^2 = 1033.828$, $df = 204$, RMSEA [95% CI] = 0.053 [0.050, 0.056], CFI = 0.942, and SRMR = 0.040. The results imply that students significantly varied in their mental well-being at the beginning of their upper secondary education (intercept $\sigma^2 = 0.452$, $p < .001$). The developmental trajectory of mental well-being was significant and negative (slope $M = -0.038$, $p < .01$) to varying degrees (slope $\sigma^2 = 0.094$, $p < .001$). The significant and negative association between the intercept and slope ($r = -.419$, $p < .001$) of mental well-being indicates that students who had higher mental well-being in the first year of upper secondary school experienced a more rapid decline of mental well-being throughout their upper secondary education than others.

The unconditional growth curve model of academic stress achieved good model fit: $\chi^2 = 10.077$, $df = 1$, RMSEA [95% CI] = 0.080 [0.040, 0.128], CFI = 0.984, and SRMR = 0.022. The results show that students were academically stressed to varying degrees in their first year of upper secondary school (intercept $\sigma^2 = 0.570$, $p < .001$). The significant and positive slope mean (slope $M = 0.201$, $p < .001$) shows that students experienced increasing levels of academic stress during upper secondary school. The significant slope variance (slope $\sigma^2 = 0.066$, $p < .01$) indicates that some experienced a more rapid increase than others. The significant and negative correlation between the intercept and slope ($r = -0.465$, $p < .001$) implies that students with a higher initial level of academic stress experienced a slower increase during upper secondary school compared to others.

3.2 The developmental associations between teacher autonomy support, mental well-being, and academic stress

The results from the parallel process latent growth curve model of teacher autonomy support, mental well-being, and academic stress are presented in Fig. 1, and more details are presented in Appendix B. The model achieved an acceptable model fit:

Table 4 Unconditional growth curve models of teacher autonomy support, mental well-being, and academic stress

	Intercept				Slope				Intercept and slope covariance	
	Unstandardised		Standardised		Unstandardised		Standardised		Unstandardised	Standardised
	M (*SE*)	σ^2 (*SE*)	*M* (*SE*)	σ^2 (*SE*)	*M* (*SE*)	σ^2 (*SE*)	*M* (*SE*)	σ^2 (*SE*)	σ (*SE*)	*r* (*SE*)
TAS	3.667*** (0.022)	0.373*** (0.043)	6.001*** (0.349)	1.000 (0.000)	−0.030* (0.015)	0.086*** (0.023)	−0.101 (0.053)	1.000 (0.000)	−0.069** (0.026)	−0.382*** (0.089)
MWB	3.500*** (0.023)	0.452*** (0.042)	5.204*** (0.244)	1.000 (0.000)	−0.038** (0.014)	0.094*** (0.020)	–0.122** (0.047)	1.000 (0.000)	−0.086*** (0.023)	−0.419*** (0.064)
AS	2.697*** (0.026)	0.570*** (0.055)	3.573*** (0.173)	1.000 (0.000)	0.201*** (0.015)	0.066** (0.026)	0.783*** (0.165)	1.000 (0.000)	−0.090** (0.031)	−0.465*** (0.076)

*** $p < .001$, ** $p < .01$, * $p < .05$. TAS teacher autonomy support, *MWB* mental well-being, *AS* academic stress, *M* mean, *SE* standard error, σ^2 variance, σ covariance, *r* standardised correlation

$\chi^2 = 2011.370$, $df = 882$, RMSEA [95% CI] = 0.034 [0.032, 0.036], CFI = 0.944, and SRMR = 0.039. The initial status of teacher autonomy support was positively and negatively, respectively, related to the initial statuses of mental well-being (β = 0.55, $p < .001$) and academic stress (β = -0.21, $p < .001$). Changes in teacher autonomy support had positive and negative associations with the trajectories of mental well-being (β = 0.46, $p < .001$) and academic stress (β = -0.30, $p < .01$), respectively. Thus, students with a high initial and slower decreasing level of perceived teacher autonomy support likely experienced a high initial and slower decreasing level of mental well-being and a low initial and a slower increasing level of academic stress than others. There was a negative correlation between the academic stress and mental well-being intercepts ($r = -.14$, $p < .01$), indicating that students who had a high initial level in one of the factors had a decreased likelihood of having a high initial level in the other factor in the first year of upper secondary school. Lastly, there was a positive association between the academic stress intercept and the mental well-being slope ($r = .16$, $p < .05$), suggesting that students with a high initial level of academic stress experienced a slower decreasing level of mental well-being during upper secondary school compared to others.

There were some significant effects of the control variables in the model, specifically regarding sex and socioeconomic status. Please see Appendix B for a more detailed description of the control variable results. Sex was positively related to the academic stress intercept (β = 0.13, $p < .001$) and negatively associated with the teacher autonomy support (β = -0.13, $p < .01$) and mental well-being (β = -0.11,

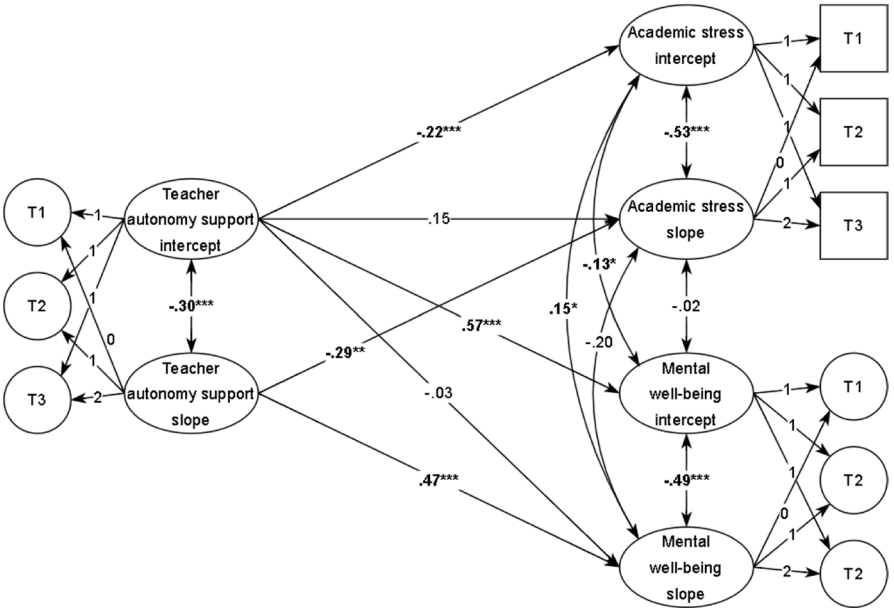

Fig. 1 The parallel process latent growth curve model of teacher autonomy support, mental well-being, and academic stress. *Note*: ***$p < .001$, **$p < .01$, *$p < .05$. The standardised estimates are presented in the figure

$p < .01$) intercepts. These associations indicate that girls experienced higher initial academic stress and lower initial teacher autonomy support and mental well-being than boys. Socioeconomic status was positively related to the intercepts of teacher autonomy support ($\beta = 0.18$, $p < .001$) and mental well-being ($\beta = 0.10$, $p < .01$), suggesting that students with a greater perceived family wealth reported higher initial teacher autonomy support and mental well-being than students with a lower perceived family wealth. Socioeconomic status had a negative relationship with the teacher autonomy support slope ($\beta = -0.15$, $p < .01$), implying that a higher socioeconomic status was related to a more rapid decline in teacher autonomy support during upper secondary school.

4 Discussion

The main aims of this study were to investigate (1) the developmental trajectories of teacher autonomy support, mental well-being, and academic stress throughout upper secondary school and (2) the effect of changes in teacher autonomy support on the trajectories of mental well-being and academic stress during this period. Our results suggest that teacher autonomy support and mental well-being decreased while academic stress increased during the three-year-long upper secondary education. Our analysis confirms the importance of teachers´ autonomy support on students' psychological and affective functioning and academic stress coping. Specifically, the results show that students with a high initial level of teacher autonomy support were increasingly likely to have a high initial level of mental well-being and a low initial level of academic stress simultaneously. Further, changes in teacher autonomy support were positively and negatively related to the trajectories of mental well-being and academic stress, respectively.

4.1 Changes in teacher autonomy support, mental well-being, and academic stress

Aligning with hypothesis 1, teacher autonomy support and mental well-being decreased while academic stress increased during upper secondary school. Because the teacher autonomy support and mental well-being scales achieved strict measurement invariance across time, the change in the factors is likely due to actual change and not a change in the perception of the constructs and what they entail. It is possible that a rapidly growing need for autonomy during adolescence (Oudekerk et al., 2015) results in a mismatch between desired and actual autonomy provided as time progresses in secondary education. For example, one study found that secondary school students wanted more autonomy than their teachers provided in subjects such as math, English, and science (Modrek et al., 2021). Perhaps teachers provide less autonomy support due to conflating autonomy support and independence, believing that the development progress for adolescents is towards independence and thus requires less autonomy support when this developmental age group actually requires more support (Ryan & Deci, 2017). In a more dismal vein, students who perceive

their teacher as highly autonomy-supportive initially in upper secondary school may be engaged learners and achieve good grades (Skinner et al., 2008), resulting in declining autonomy support provided during their education due to said independence and drive.

The increasing level of academic stress might be related to the growing societal focus on educational attainment (West & Sweeting, 2003), resulting in various educational pressure and demands of secondary education (Dewald et al., 2014; Pascoe et al., 2020), poor psychological health (Sweeting et al., 2010) and high stress (Leonard et al., 2015; McGraw et al., 2008; Moeller et al., 2020). The progressively larger academic pressure and 'toxic' learning environments might negatively impact students' well-being (Boen et al., 2020). Thus, although the association between the slopes of mental well-being and academic stress was non-significant, there might be important factors underlying both developmental trajectories. For example, boredom is predictive of well-being (Schwartze et al., 2021), which also increases depression, anxiety, and stress when people have low mindfulness (Lee & Zelman, 2019). Future studies might include such predictors to further our knowledge of developmental changes in school-related stress and wellness in adolescence. We also found that students with a higher initial level of academic stress experienced a slower increase in academic stress and a slower decrease in mental well-being across upper secondary education. One interpretation of this finding is that as students' progress, learn coping skills, and master subjects, their experience of academic stress might decrease (Lazarus, 2006). Further, with a growth in coping skills, the decline in mental-well-being might become less severe throughout secondary school (Evans et al., 2018). This might be especially prominent in students with initial high academic skills. Of note, a final interpretation could be that the students with a high initial level in the study's constructs experienced a ceiling effect, resulting in a more rapid decline or slower increase in the corresponding factors.

4.2 The developmental associations between teacher autonomy support, mental well-being, and academic stress

In support of hypothesis 2 and theoretical assumptions of SDT, the initial status of teacher autonomy support was positively related to the initial status of mental well-being and negatively associated with the initial status of academic stress. The teacher autonomy support slope was positively associated with the mental well-being slope and negatively related to the academic stress slope. According to self-determination theory, need satisfaction is promoted by autonomy support, resulting in positive growth, wellness, and thriving (Deci & Ryan, 2008; Ryan & Deci, 2017). Although we did not measure need satisfaction directly, our study aligns with this assumption, suggesting explanatory mediators. Kleinkorres et al. (2023) found that the developmental trajectories of teacher autonomy support and well-being (i.e., satisfaction with school, enjoyment of school, and self-rated health) were positively associated. Further, studies indicate that teacher autonomy support functions as a buffer against the development of anxiety and depression over time (Murberg & Bru, 2009; Yu et al., 2016). Our findings suggest that teacher autonomy support is not only crucial to positive school experiences

and health but also to how stressed students become about school- and homework and their mental well-being—a complex construct encompassing both psychological and affective functioning with two distinct aspects of psychological well-being: eudaemonia (doing well) and hedonism (feeling well) (Ryan & Deci, 2001).

4.3 The effect of sex and socioeconomic status on teacher autonomy support, mental well-being, and academic stress

The model results suggest that sex and socioeconomic status accounted for some of the initial statuses and changes in teacher autonomy support, mental well-being, and academic stress. The results indicate that girls started upper secondary school with higher academic stress and lower perceived teacher autonomy support and mental well-being than boys (see Appendix B). Because the rate of change in academic stress, mental well-being, and teacher autonomy support was similar across the sexes, we can assume that girls have less favorable initial statuses and, therefore, developments in the study's constructs compared to boys during upper secondary school. Aligning with our findings, girls are more likely to experience higher levels of academic stress (Kristensen et al., 2023) and decreasing well-being during adolescence (Petts, 2014) than boys. However, in contrast to our findings, some previous research indicates that boys tend to experience less teacher support than girls (Lietaert et al., 2015).

Higher socioeconomic status was positively related to greater mental well-being and teacher autonomy support during the first year of upper secondary school. From a resource perspective, students with a high socioeconomic background might have more favorable mental well-being during the beginning of upper secondary school due to advantageous external support systems, such as better access to material and social resources (Robert & Robert, 2002). This effect might last, leading to a stable mental well-being trajectory for students with a higher socioeconomic status compared to a lower socioeconomic status. Aligning with the association between socioeconomic status and initial teacher autonomy support, Hornstra et al. (2015) found that teachers experienced it being harder to teach at-risk students than students with high abilities and good behavior, background characteristics, and motivation in autonomy-supportive ways. However, higher socioeconomic status was also related to a more rapid decline in teacher autonomy support throughout education. This finding directly contrasts previous studies, indicating that teachers may have negative attitudes or bias toward low socioeconomic students (Auwarter & Aruguete, 2008; Bloem et al., 2023). We encourage further inquiry into sex and socioeconomic differences in teacher autonomy support, mental well-being, and academic stress, which could provide valuable knowledge for intervention strategies and theory development.

4.4 Limitations and future directions

There are some limitations worth mentioning before interpreting the results of our study. One limitation is that academic stress and socioeconomic status were measured using single indicators. Thus, the reliability of the measures is unknown and impossible to test, and the indicators might be biased due to random and non-random

errors. We advise caution when interpreting the results related to these measures. However, the academic stress item has been validated and functions satisfactorily as an academic stress indicator (Klinger et al., 2015). Moreover, if a single indicator appropriately measures what is intended, using scales with multiple items might be redundant and ambiguous (Allen et al., 2022). Although the socioeconomic status measure is a single self-reported indicator, it has been found to correlate more strongly with overall health, life satisfaction, social competence, health complaints, and self-esteem than other socioeconomic measures, such as family affluence in adolescent samples in Norway (Iversen & Holsen, 2008).

Another limitation is the sole focus of autonomy support. Researchers within SDT have recently investigated the control and indifference toward supporting students' basic needs (Bhavsar et al., 2019; Cheon et al., 2019). There has been an extension investigating whether the context is supportive, controlling, or indifferent towards students. The inclusion of these other contextual states could have provided a more nuanced result. Although teacher autonomy support is the most studied contextual support due to its cross-over effects to the other needs (i.e., competence and relatedness) and thus important to adolescent outcomes in its own right (Bureau et al., 2022; Okada, 2022), we recommend future studies include other contextual states in their analyses.

Similarly, our focus in this study was on the directional effect of autonomy support on psychological and affective functioning. We recommend that future studies include basic need satisfaction and controlled and autonomous motivations as mediators. These inclusions could further contribute to our understanding of the mechanisms of the changes in teacher autonomy support on academic stress and mental well-being during adolescence.

Another limitation of this study might be the sole reliance on self-reported measures, which may lead to common method bias (Doty & Glick, 1998) and an overestimation of the associations between the study variables. To examine if one latent variable was accountable for the variance in the study's data, we performed a post hoc Harman's single factor test for each time point (Sea-Jin et al., 2010). The results indicated that a single factor did not account for the majority of the variance. The variance percentage of one extracted variable, including all indicators on all measurement occasions, was smaller than 40 percent. In other words, multiple factor solutions were more appropriate for each time point. Related to this, students were asked to assess multiple teacher' provision of autonomy support. There could be domain-specific differences in terms of providing autonomy support and between teachers. It is thus unclear if students take an average across multiple teachers and domains or if they are considering one single teacher from one particular context. We recommend that future studies assess students´ perceived autonomy support from a single teacher.

A final limitation is the attrition from T1 to T3 (51,4% responded on all three time points). Although this is common in longitudinal research, including all participants across all three time points would have been desirable. However, our missing analyses showed that the missingness was completely at random and thus not due to methodological design or respondents, suggesting the data is still representative of the population. Furthermore, our data consisted of a relatively large sample,

and because we used advanced missingness techniques such as FIML, more data information was retained from our participants. Additionally, by using panel data stretching across a three-year-long education and subsequently establishing longitudinal measurement invariance of the constructs, we can, with increasing confidence, determine the developmental change in factors and the association between the trajectories throughout an upper secondary education.

4.5 Practical implications

Some important implications for (1) educational practices and (2) students' psychological and affective functioning and academic stress coping can be derived from this study. First, because academic stress increased during upper secondary education in our sample, adolescents might need improved coping techniques to handle the various environmental and academic stressors surrounding them in this period. For instance, multisectoral approaches across education, health, and social services might promote adolescents' cognitive skills to cope with stress through empowerment (Rew et al., 2014). Further, school-based interventions in secondary education employing coping strategies such as mindfulness, breathing exercises/meditation, cognitive-behavioral stress management, and therapy sessions are particularly effective in reducing school-related psychological stress (van Loon et al., 2020) as well as physiological (i.e., blood pressure) stress (van Loon et al., 2022). Because secondary school students develop fewer close relationships with others, particularly teachers, compared to primary school students (Tobbell & O'Donnell, 2013), there are smaller effects of universal implementation programs in secondary schools (van Loon et al., 2020) than in primary schools (Kraag et al., 2006). It is possible that more targeted, as opposed to universal, intervention programs to reduce academic stress are more effective in secondary school samples, as shown in targeted school-based depression interventions in adolescence (Werner-Seidler et al., 2017). Thus, we argue that there is a need for early screenings of students' academic adjustments at the beginning of upper secondary school and targeted follow up measures to reduce school-related stress throughout the education.

Second, similar to our results, Kleinkorres et al. (2023) found that students with higher initial enjoyment of school and self-rated health were more likely to experience more rapid decreases in corresponding constructs, suggesting that secondary school students with high initial well-being tend to experience more dramatic declining levels of well-being compared to others. Moreover, this study found a positive association between the initial status of academic stress and the trajectory of mental well-being. Thus, there might be practical challenges in providing efficient intervention programs to improve students' mental well-being during upper secondary school. On the one hand, students with high initial academic stress should arguably be targets of measures designed to promote their academic adjustment. On the other hand, these students had a more favorable trajectory of mental well-being than students with a lower initial academic stress level in our sample. One possibility is to provide universal measures to improve mental well-being (Hale et al., 2021; Lam & Lam, 2023) and simultaneously

implement directed measures to identify and target at-risk students (Severson et al., 2007) concerning rapidly decreasing mental well-being.

Lastly, although teachers spend somewhat limited time in each classroom, they might be uniquely positioned to improve mental well-being and reduce school-related stress in students. Our results imply that positive changes in teacher autonomy support might provide students with increasingly better capabilities to handle their academic workload, reducing academic stress and improving their psychological and affective functioning, increasing happiness and flourishing. The school system should focus on implementing measures designed to provide teachers with the necessary knowledge and skills to be autonomy-supportive in the classroom (for an overview of motivational behaviors, see Ahmadi et al., 2023). Although we acknowledge that the governing political parties mainly execute major decisions regarding school practices, Norwegian upper secondary education teachers are free to design their instructions as long as they follow national curriculum guidelines. Furthermore, autonomy-supportive teaching practices greatly coincide with the Norwegian national curriculum for secondary education practices, such as providing an inclusive learning environment (Ministry of Education & Research, 2017). Similarly, because classroom climates highly focused on performance are related to higher academic stress and increased emotional problems (Tharaldsen et al., 2022), teachers can focus on adapting their classrooms to be mastery-oriented. Because the effect of mastery goals on interest, enjoyment, and behavioral engagement is particularly salient when teachers are autonomy-supportive (Benita et al., 2014), teachers should strive to increase students' feelings of autonomy and adapt the classroom climate to be mastery-oriented.

Appendix

See Tables 5 and 6.

Table 5 Measurement invariance of perceived teacher autonomy support and mental well-being across sex

	χ^2	*df*	RMSEA [90%CI]	CFI	SRMR	ΔRMSEA	ΔCFI	ΔSRMR
Perceived teacher autonomy support								
T1								
Configural[b]	29.398	8	0.068 [0.043, 0.095]	0.994	0.014			
Metric	33.336	12	0.055 [0.034, 0.078]	0.994	0.028	−0.013	0.000	0.014
Scalar	51.848	17	0.060 [0.041, 0.078]	0.990	0.060	0.005	−0.004	0.032
Partial scalar[c]	**50.759**	**16**	**0.061 [0.043, 0.081]**	**0.990**	**0.057**	**0.001**	**0.000**	**−0.003**
T2								
Configural[b]	13.974	8	0.040 [0.000, 0.075]	0.998	0.009			
Metric	18.500	12	0.034 [0.000, 0.064]	0.998	0.033	−0.006	0.000	0.024
Scalar	**32.258**	**17**	**0.044 [0.020, 0.068]**	**0.995**	**0.060**	**0.010**	**−0.003**	**0.027**
T3								
Configural[b]	24.453	8	0.066 [0.037, 0.097]	0.996	0.011			
Metric	**26.715**	**12**	**0.051 [0.025, 0.077]**	**0.996**	**0.023**	**−0.015**	**0.000**	**0.012**
Scalar	51.505	17	0.066 [0.046, 0.087]	0.991	0.080	0.015	−0.005	0.057
T1—T3								
Configural	416.628	154	0.049 [0.043, 0.055]	0.976	0.048			
Metric	439.013	169	0.047 [0.042, 0.053]	0.975	0.062	−0.002	−0.001	0.014
Scalar	518.915	194	0.049 [0.044, 0.054]	0.970	0.086	0.002	−0.005	0.024
Strict	**621.483**	**219**	**0.051 [0.046, 0.056]**	**0.963**	**0.086**	**0.002**	**−0.007**	**0.000**
Mental well-being								
T1								
Configural[d]	106.797	24	0.078 [0.063, 0.093]	0.984	0.020			
Metric	116.676	30	0.071 [0.058, 0.085]	0.983	0.037	−0.007	−0.001	0.017
Scalar	238.132	37	0.097 [0.086, 0.109]	0.961	0.086	0.026	−0.022	0.049
Partial scalar[a]	**149.465**	**35**	**0.076 [0.063, 0.088]**	**0.978**	**0.066**	**−0.021**	**0.017**	**−0.020**
T2								
Configural[e]	82.263	20	0.083 [0.065, 0.102]	0.985	0.025			
Metric	91.813	26	0.075 [0.058, 0.092]	0.984	0.042	−0.008	−0.001	0.017
Scalar	163.722	33	0.093 [0.079, 0.108]	0.968	0.089	0.018	−0.016	0.047
Partial scalar[C]	**121. 696**	**32**	**0.079 [0.064, 0.094]**	**0.978**	**0.070**	**−0.014**	**0.010**	**−0.019**
T3								
Configural[b]	80.794	26	0.065 [0.049, 0.081]	0.986	0.021			
Metric	86.513	32	0.058 [0.044, 0.073]	0.986	0.032	−0.007	0.000	0.011
Scalar	177.150	39	0.084 [0.072, 0.097]	0.964	0.073	0.026	−0.022	0.041
Partial scalar[C]	**110.300**	**38**	**0.062 [0.048, 0.075]**	**0.981**	**0.056**	**−0.022**	**0.017**	**−0.017**
T1—T3								
Configural	1179.622	358	0.056 [0.053, 0.060]	0.942	0.040			
Metric	1220.478	379	0.056 [0.052, 0.059]	0.940	0.054	0.000	−0.002	0.014
Scalar	1442.308	400	0.060 [0.057, 0.064]	0.926	0.065	0.004	−0.014	0.011
Partial scalar[a]	1364.844	398	0.058 [0.055, 0.062]	0.932	0.061	−0.002	0.006	−0.004
Partial strict	**1466.200**	**433**	**0.058 [0.054, 0.061]**	**0.927**	**0.070**	**0.000**	**−0.005**	**0.009**

Model modifications to achieve acceptable model fit: [a]two item intercept constraints released, [b]one error covariance added, [C]one intercept constraint released, [d]two error covariances added, [e]four error covariances added. The accepted levels of invariance are enhanced in bold.

Table 6 Parallel process growth curve model results

	Unstandardised			Standardised		
	Est	SE	95% CI	Est	SE	95% CI
Regression coefficients						
Main effects						
TAS intercept → AS intercept	−0.270***	0.058	−0.383, −0.157	−0.207***	0.042	−0.288, −0.126
TAS intercept → AS slope	0.064	0.034	−0.003, 0.131	0.146*	0.073	0.004, 0.288
TAS intercept → MWB intercept	0.631***	0.064	0.505, 0.758	0.552***	0.044	0.465, 0.639
TAS intercept → MWB slope	−0.016	0.035	−0.084, 0.053	−0.030	0.067	−0.161, 0.101
TAS slope → AS slope	−0.249**	0.067	−0.380, −0.118	−0.295***	0.091	−0.473, −0.118
TAS slope → MWB slope	0.462***	0.083	0.299, 0.624	0.455***	0.053	0.351, 0.560
Control variable effects						
Sex → TAS intercept	−0.150***	0.045	−0.239, −0.060	−0.125**	0.041	−0.206, −0.045
Sex → TAS slope	−0.061	0.064	−0.186, 0.064	−0.099	0.105	−0.305, 0.107
Sex → AS intercept	0.196***	0.045	0.107, 0.285	0.126***	0.029	0.069, 0.182
Sex → AS slope	0.040	0.035	−0.029, 0.109	0.077	0.065	−0.049, 0.204
Sex → MWB intercept	−0.146	0.082	−0.306, 0.014	−0.107	0.056	−0.217, 0.004
Sex → MWB slope	0.012	0.057	−0.100, 0.123	0.019	0.090	−0.157, 0.194
SES → TAS intercept	0.126***	0.030	0.067, 0.186	0.176***	0.042	0.094, 0.257
SES → TAS slope	−0.057*	0.023	−0.102, −0.012	−0.152*	0.067	−0.283, −0.020
SES → AS intercept	−0.033	0.045	−0.121, 0.054	−0.035	0.048	−0.129, 0.058
SES → AS slope	−0.021	0.015	−0.051, 0.009	−0.067	0.052	−0.168, 0.034
SES → MWB intercept	0.085**	0.030	0.027, 0.143	0.103**	0.037	0.030, 0.176
SES → MWB slope	0.037	0.019	0.000, 0.073	0.097*	0.049	0.000, 0.193
Immigration BG → TAS intercept	0.047	0.103	−0.156, 0.249	0.021	0.045	−0.068, 0.109
Immigration BG → TAS slope	−0.073	0.075	−0.220, 0.075	−0.061	0.065	−0.189, 0.066
Immigration BG → AS intercept	0.168*	0.076	0.020, 0.316	0.056	0.026	0.006, 0.107
Immigration BG → AS slope	−0.029	0.047	−0.122, 0.064	−0.029	0.048	−0.124, 0.065
Immigration BG → MWB intercept	0.025	0.079	−0.130, 0.180	0.010	0.031	−0.050, 0.070
Immigration BG → MWB slope	0.111	0.079	−0.045, 0.266	0.092	0.063	−0.032, 0.217
Intervention 1 → TAS intercept	−0.047	0.046	−0.137, 0.043	−0.040	0.038	−0.114, 0.035
Intervention 1 → TAS slope	−0.013	0.061	−0.132, 0.106	−0.021	0.100	−0.217, 0.174
Intervention 1 → AS intercept	−0.120	0.073	−0.263, 0.023	−0.078	0.047	−0.170, 0.014
Intervention 1 → AS slope	0.029	0.047	−0.064, 0.107	0.057	0.089	−0.118, 0.232

Table 6 (continued)

	Unstandardised			Standardised		
	Est	SE	95% CI	Est	SE	95% CI
Intervention 1 → MWB intercept	0.024	0.089	−0.149, 0.198	0.018	0.065	−0.110, 0.146
Intervention 1 → MWB slope	0.054	0.029	−0.003, 0.111	0.087	0.049	−0.009, 0.182
Intervention 2 → TAS intercept	0.102	0.060	−0.016, 0.220	0.085	0.050	−0.013, 0.183
Intervention 2 → TAS slope	−0.023	0.058	−0.137, 0.091	−0.037	0.093	−0.220, 0.146
Intervention 2 → AS intercept	−0.094	0.077	−0.246, 0.058	−0.060	0.049	−0.156, 0.036
Intervention 2 → AS slope	−0.015	0.043	−0.099, 0.069	−0.028	0.082	−0.190, 0.133
Intervention 2 → MWB intercept	−0.069	0.066	−0.199, 0.061	−0.050	0.049	−0.147, 0.046
Intervention 2 → MWB slope	0.045	0.025	−0.005, 0.095	0.071	0.043	−0.013, 0.155
Correlation coefficients						
TAS intercept ↔ TAS slope	−0.050*	0.020	−0.090, −0.010	−0.297**	0.098	−0.490, −0.105
MWB intercept ↔ MWB slope	−0.071**	0.024	−0.118, −0.023	−0.490***	0.082	−0.651, −0.330
MWB intercept ↔ AS intercept	−0.056***	0.016	−0.087, −0.025	−0.144***	0.043	−0.227, −0.060
MWB intercept ↔ AS slope	0.004	0.010	−0.016, 0.024	0.032	0.083	−0.131, 0.195
MWB slope ↔ AS intercept	0.031*	0.014	0.004, 0.057	0.155*	0.066	0.025, 0.285
MWB slope ↔ AS slope	−0.013	0.010	−0.032, 0.006	−0.202	0.148	−0.491, 0.087
AS intercept ↔ AS slope	−0.092***	0.031	−0.132, −0.051	−0.532***	0.071	−0.671, −0.393

***$p < .001$, **$p < .01$, *$p < .05$. *TAS* teacher autonomy support, *MWB* mental well-being, *AS* academic stress

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Data availability Materials and analysis code for this study are available by emailing the corresponding author.

Declarations

Conflict of interests We have no known conflict of interest to disclose.

Ethical approval Data were collected with approval from the Norwegian Centre for Research Data (NSD), and parent/guardian consent to participate in the study was obtained for participants below the age of 16.

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