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Teachers' Stress and Professional Learning: A Day-to-Day and Teacher-to-Teacher Investigation

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Samenvatting To keep pace with rapid societal changes, teachers must continuously invest time and effort in professional development. Yet, teaching is a demanding profession that often involves substantial work-related stress, which may influence teachers' engagement in professional learning activities. In this study, we collected data from 151 secondary school teachers over 15 consecutive workdays to examine how work-related stress relates to both the quality and quantity of their professional learning. Drawing on previous literature, we hypothesized that higher levels of stress would be linked to lower commitment to professional development activities, both between teachers and on a day-to-day basis. The findings were partly contradictory. While cross-sectional measures indicated that increased stress tends to lower engagement in professional learning, the daily measures presented a more nuanced scenario, showing that stress does not always act as a barrier and may sometimes even coincide with heightened effort. These results underscore the importance of considering both overarching beliefs about the teaching profession and the specific time frames used to capture stress and learning. Ultimately, this study suggests that stress, depending on the context, can both impede and potentially stimulate teachers' professional growth, emphasizing the need for carefully chosen measurement intervals and more refined interpretations of stress in educational practice.

Keywords teacher professional learning, work-related stress, daily measures

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Belangen

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1 Introduction

To successfully manage the rapidly changing demands of 21st-century work and society, teachers must continuously develop their professional skills, attitudes, and behavior (van Eekelen et al., 2005, 2006; Vermunt & Endedijk, 2011). They need to keep pace with changes in subject content, student populations, and teaching methods, and their ongoing professional learning is often assumed to positively affect student learning (Admiraal et al., 2015; Darling-Hammond, 2008). However, teachers' engagement in professional development (PD) activities is not guaranteed. Factors such as workplace context, teaching experience, prior learning experience, and overall well-being can explain why some teachers make better use of professional learning opportunities than others (Kyndt & Baert, 2013; van Eekelen et al., 2006). In the Netherlands, for instance, teachers reportedly do not fully exploit available learning opportunities (Algemene Onderwijsbond, 2017).

Teacher well-being is an important antecedent of professional learning (Kyndt & Baert, 2013). Yet, the relationship between teachers' work-related stress—a central aspect of their well-being (Viac & Fraser, 2020)—and their commitment to professional learning activities remains under-examined. Stress can lead to absenteeism, poor performance, and burnout (Fernet et al., 2012; Klassen, 2010; Skaalvik & Skaalvik, 2015), potentially limiting teachers' time and energy for professional learning. When teachers experience stress as a threat, it may trigger avoidance coping strategies, reducing the effort they invest in acquiring new skills (see Cooper et al., 2001; Folkman et al., 1986; Lepine et al., 2004). Previous research on work pressure—an aspect related to stress—produced mixed results (Raemdonck et al., 2013; Taris et al., 2010). This may be because work-pressure can be perceived both as a challenge and a threat by teachers (see Blascovich, 2008). Focusing specifically on threat-related stress responses like anxiety may yield clearer insights.

Another reason for previous mixed results regarding teachers' stress-related experiences and their professional learning may be that previous research was cross-sectional and, as such, did not distinguish between within- and between-teacher differences in teachers' stress and learning. To study within-teacher processes between these, distinguishing within- from between-differences is essential. In cross-sectional samples, the relative amount of within- and between-teacher variation cannot be determined and may vary from sample to sample, affecting effect sizes in each (Molenaar, 2004; Murayama et al., 2017; Schuurman, 2023). Importantly, work-related stress is not just a stable trait but also a state that fluctuates due to ever-changing daily circumstances at work (Bower & Carroll, 2017; Schmidt et al., 2017; Skaalvik & Skaalvik, 2015). Teachers' stress levels can vary from one day to the next (Van Alphen, 2022), as can their available time and motivation for professional learning. Examining daily

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stress and learning commitments can thus reveal whether short-term stress fluctuations actually impede or occasionally coincide with teachers' professional learning efforts. This approach is particularly relevant in a profession where unpredictable classroom events, scheduling changes, and other contextual factors can alter teachers' stress and engagement levels rapidly.

Against this backdrop, we aim to offer a more nuanced perspective on how work-related stress relates to commitment to professional learning, both across teachers and within teachers over time. By comparing traditional cross-sectional measurements to more dynamic, daily assessments, we seek to understand whether and how short-term stress fluctuations affect the quality (effort) and quantity (time) of teachers' engagement in professional learning activities. To our knowledge, this study is the first to use intensive longitudinal data to capture these daily dynamics.

Teachers' commitment to professional learning activities

For the present study, we define professional learning as the engagement in activities at or outside of the workplace, during which teachers or groups of teachers acquire and/or improve competencies (integrated knowledge, skills, and attitudes) that change their present and future professional achievement and organizational performance (Kyndt & Baert, 2013). Specifically, we investigate teachers' commitment to conscious, self-directed and intentional learning (van Eekelen et al., 2005; Louws et al., 2017).

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Teachers may choose to intentionally commit time and effort to a wide range of different activities at the workplace, some of which are formal and others informal (Richter et al., 2011). Formal learning activities are commonly organized by the employer or external agents, include structured learning environments, and are usually based on a curriculum (Richter et al., 2011). These include, for instance, workshops or lectures organized at school. Many countries require their teachers to attend such formal activities (Forsthuber et al., 2009). Therefore, they are a widely used form of professional learning (Richter et al., 2011). In contrast to formal learning, informal learning is organized by teachers themselves, based on their own learning goals and strategies, and usually does not follow a structured curriculum (Richter et al., 2011; Vermunt & Endedijk, 2011). This type of professional learning may include activities such as studying professional literature, experimenting with new pedagogical approaches during class, reflecting on lessons, and collaborating to improve lessons or school policy (Evers et al., 2016). Although formal and informal learning are often contrasted, it may be better to consider them as part of the same continuum – ranging from organized (formal) to less organized learning (Colley et al., 2003).

We further conceptualize teachers' commitment to professional learning activities, either formal or informal, to have a quantitative aspect (i.e., the amount of time teachers put into learning activities) and a qualitative aspect

(i.e., the effort with which teachers perform learning activities). Hereby, effort is seen as the expenditure of (mental) energy, dedication, and persistence in the face of difficulty when performing professional learning activities (see Colquitt et al., 2000; Jansen et al., 2020; Schaufeli et al., 2002).

Work-related stress, experienced as feelings of anxiety

To define the concept of work-related stress, we draw on the widely applied cognitive theory of stress and coping (e.g., Folkman et al., 1986; 1999), which describes stress as the result of a mismatch between a persons' needs (e.g., goals) and situational demands. Accordingly, stress is seen as an individual's psychological response to a situation in which something is at stake, and for which personal resources are insufficient (Lepine et al., 2004).

According to the cognitive theory of stress and coping, whether a person experiences stress is determined by their appraisal of the potentially stressful situation and their available resources (see Folkman et al., 1986; Lazarus, 1999; Lepine et al., 2004), in other words: an assessment determines the stress response and consequent coping mechanisms. To understand the different mechanics at play, we will use an example of a student who disrupts class. The teacher may appraise this disruption as either a challenge or a threat. If appraised as a challenge, then the teacher views the situation as changeable and expects to attain a positive outcome by engaging with the problem. This teacher may still experience a degree of work-related stress, but the situation is not experienced as debilitating. On the contrary, the teacher rises to the challenge and adopts a problem-focused coping approach. This means that the teacher expects to possess enough personal resources to meet the challenge (Folkman, 2008; Folkman et al., 1986; Lepine et al., 2004).

Conversely, when the teacher feels that the situation is threatening and beyond their control, they may appraise the situation as a threat. The result of assessing the situation as unsolvable and threatening can lead to the adoption of an avoidance coping strategy. This means that the teacher chooses to ignore the student, or otherwise does not engage with the display of disruptive behaviour. In other words; they will try to meet their personal needs to continue the lesson and protect their well-being by distancing themselves mentally, emotionally, or physically (e.g., withdrawing and hoping the situation will resolve itself). Whether or not this resolves the problem, the resulting experience for the teacher is likely to be an emotion-based response, characterized by feelings of anxiety (Folkman, 2008).

Such work-related anxiety appears salient for teachers (Anderson, 1996; Frenzel et al., 2016), and is experienced by teachers as feelings of worry, nervousness and tension regarding their work (Keller et al., 2014; Van Alphen, 2022). Additionally, these feelings appear to vary from teacher to teacher (Hansen & Sullivan, 2003; Kyriacou, 2001; Wettstein et al., 2021), and from day

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to day (Aldrup et al., 2017; Lavy & Eshet, 2018; Schmidt et al., 2017; Simbula, 2010; Van Alphen, 2022). In short, teachers' work-related stress is experienced and expressed as anxiety and more than a consistent (i.e., stable) feeling, but one that varies on a daily basis. As such, this current contribution is focused on both the fast-changing daily aspect of stress within teachers and the more stable differences between teachers.

Work-related stress and commitment to professional learning activities

Following the cognitive theory of stress and coping described above, we expect stress and commitment to professional learning to be negatively related, both from a day to day and from teacher to teacher perspective. This is because if teachers appraise a situation as unchangeable and threatening they are likely to adopt an avoidance coping approach (Folkman et al., 1986; see Lepine et al., 2004). As argued above, this would mean that these teachers avoid interacting with the problem at hand. Consequently, not seeking solutions, or means to resolve the situation. It follows then that the quality and quantity of related commitment to professional learning activities would decline. This scenario seems likely because choosing to avoid a difficult situation may be especially tempting in a setting where teachers are pressed for time (Admiraal et al., 2015), fatigued (Lepine et al., 2004), and under pressure to perform their primary teaching tasks. In short, based on the cognitive theory of stress and coping, we expect teachers who show more work-related stress to also commit less to professional learning activities.

However, as of yet, no empirical findings support this notion regarding such a negative relationship between stress and commitment to professional learning. Closely related investigations into the differences among students' stress experiences suggest that learning performance is indeed negatively related to exhaustion caused by hindrances (Lepine et al., 2004). The more hindrances students encounter, the more draining their experience, resulting in greater levels of fatigue. However, in addition to targeting students, this study included a single occasion measure, meaning that the causal direction of this relationship between stress and professional learning remains unclear. Additionally, the operationalization of stress largely pertained to stressors (i.e., sources of stress), instead of stress emotions, such as anxiety. Therefore, although indicating that stress indeed could have a negative effect on commitment to professional learning, existing research does not provide enough empirical foundation for strong conclusions. Moreover, existing studies on teacher stress mainly compare teachers among each other, thereby overlooking changes in stress within teachers themselves and how these relate to changes in other variables (Collie & Mansfield, 2022; Harmsen et al., 2018).

Investigating the relationship between work-related stress and commitment to professional learning activities from day to day allows for a better

investigation of cause and effect. This is important because to aid teachers in their commitment to professional learning, it is necessary to understand if stress is indeed the cause and not the result of increased commitment to professional learning. Lastly, to our knowledge, no research currently exists that focuses on the daily change in professional learning. Meaning, that investigating professional learning in this matter, in tandem with stress, provides insight into how they (co)vary daily. This further benefits our understanding of how teachers opt to commit their valuable time and effort to professional learning when experiencing work-related stress.

In short, the cognitive theory of stress and coping suggests a negative relationship between stress and commitment to professional learning, both at the teacher-to-teacher and day-to-day levels. We examined this by asking teachers about their overall work-related stress and learning commitment, which likely reflects their broader job experience and beliefs. However, these overarching views may be less salient for daily assessments. It remains unclear whether these different approaches produce divergent outcomes. Hence, our expectations are as follows: For the comparison between teachers, in other words the teacher-to-teacher relationship (between-teacher level):

1. we hypothesize that teachers who experience more work-related stress report less quality and quantity of commitment to professional learning activities.

For the day-to-day relationship (within-teacher level):

2. we expect that on days that teachers experience more work-related stress they report less quality and quantity of commitment to professional learning activities.
3. we expect work-related stress to negatively predict quality and quantity of commitment to professional learning activities from one day to the next, controlling for previous day professional learning.

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2 Method

Sample and procedure

Our sample was derived from six secondary schools in the Netherlands. The school board of these schools opted to participate in a response to an advertisement detailing the research in a professional magazine for Dutch teachers. Together, these schools provide the full range of educational tracks in the Dutch secondary school system to over 2500 students, typically aged 12 to 18 years old. These schools employed 279 teachers.

Teachers were instructed during staff meetings (online in four schools, in-person for the others), where they were introduced to the study and asked to complete a self-report questionnaire and install a smartphone application.

Two weeks later, they received short daily questionnaires on workdays for 15 consecutive days via the app or email. Participation was voluntary and confidential, and teachers could withdraw at any time. The study followed the guidelines of the Ethics Review Board of the Faculty of Social and Behavioral Sciences (case no. 2020-CDE-11699).

The final sample comprised *N* = 151 teachers, who completed the traditional questionnaire and at least one daily questionnaire. The range for daily completion of the questionaries was between 1 and 15 (*M* = 7.14, *SD* = 4.21), with the total number of completed questionnaires being *N* = 1269. Given the fact that the average number of days that teachers worked weekly was 4.03 (i.e., 80.69% of a full-time workweek), the expected number of daily questionnaires was *N* = 1828. Therefore, the daily response rate was 69.42%. On average, participating teachers were 42.50 years old (*SD* = 11.34) and had 13.99 years of teaching experience (*SD* = 9.78). The percentage of females in this sample is 53.90%.

Measures

Cross-sectional measures in the traditional self-report questionnaire

To measure differences between teachers in their stress and commitment to learning (quantity and quality), first of all, data was collected with a digital, single-occasion self-report questionnaire.

Quantity of commitment to professional learning was measured with the Teacher Professional Development at Work (TPD@Work) scale (Evers et al., 2016). This scale consists of 21 items, measuring six types of professional learning activities, namely: experimenting in school (e.g., "How often do you experiment with new pedagogical methods during class"), collaborating to improve school (e.g., "How often do you discuss educational innovations with colleagues"), collaborating to improve lessons (e.g., "How often do you prepare lessons with colleagues"), keeping up-to-date through work-related training (e.g., "How often do you participate in a course where pedagogical methods are taught"), keeping up-to-date by reading (e.g., "How often do you study professional literature"), and reflecting (e.g., "How often do you evaluate your strengths and weaknesses") and asking for feedback (e.g., "How often do you adjust you lessons based on feedback from students"). The Likert-type answering scale for these items ranged from 1 (Almost never) to 5 (Frequently). The reliability of these individual scales ranged from McDonald's omega (ω) = .66 to .90.

Quality of commitment to professional learning was measured by seven items derived from the School Investment Scale (SIS) (Roede, 1989). The original scale reflected the persistence, direction, and intensity of student behavior regarding their commitment to learning activities. To fit the teacher context, we included the items that were specifically applicable to teachers. For example, an item measuring the persistence of teachers was "While working on my professional learning activities, I continue to work uninterruptedly". Likewise, the direction

(e.g., “I start working on professional learning on my own accord”) and intensity (e.g., “I work hard on my professional learning”) items were reworded to fit the context of teacher professional learning. To ensure that teachers understood to what kind of professional learning activities this scale referred, this scale was preceded by the TPD@Work scale (Evers et al., 2016) on commitment quantity. Items were rated on a Likert scale ranging from 1 (Almost never) to 9 (Almost always). In our sample, the reliability of the scale was ω = .81.

Work-related stress was measured through a set of four items from the Dutch version of the Spielberger State-Trait Anxiety Inventory (STAI; (van der Ploeg, 1982)). For this study, items were preceded by the phrase “When I’m working …”. Only the items of the trait-part of the questionnaire that referred to negative emotions (e.g., “I feel nervous and uneasy”), cognitions (e.g., “I worry too much about minor issues”), and physical reactions (e.g., “I get tense and agitated when thinking about recent troubles) were used. The answering scale for these items ranged from 1 (Almost never) to 4 (Almost always) and its reliability was ω = .85.

Daily questionnaire

To measure daily differences in stress and commitment to professional learning, a daily questionnaire was sent to teachers via a smartphone push notification at 5 p.m., with an additional reminder at 9 p.m. Both the invitation and reminder were additionally sent to participants via e-mail. This email contained a link that allowed the participant to complete the questionnaires on any other device. The questionnaire of a particular day could not be completed on the following day, ensuring that the measure corresponded to the experiences of that specific day.

Daily quantity of commitment to professional learning was measured through a single question that was presented every day. This question read: “Today, how much time did you spend on professional learning activities?”. Respondents could respond by filling in the number of minutes they had committed that day to learning activities. Preceding this question, examples of professional learning activities from the Evers et al., (2016) scale were presented to offer guidance to participants.

Daily quality of commitment to professional learning was measured by four items derived from the SIS (Roede, 1989), measuring the intensity with which teachers learned from day to day. All four items were rated using digital sliders that respondents could move between values of zero (Completely not applicable to me) and 100 (Completely applicable to me). This fine-grained rating scale was used to allow teachers to report small increases or decreases in their learning commitment. To reduce the number of items that teachers had to complete, and to prevent the boredom of having to fill out the same set of items on every occasion, a planned missing data design was employed (Enders, 2010). The item “Today, I worked hard on my professional learning” was presented every day, and respondents completed a random selection of two of the other items. The

reliability of the scale was assessed using the multi-level confirmatory factor analysis procedure outlined by Van Alphen, (2022). This procedure resulted in a reliability coefficient of this scale for measuring trait-like between-teacher differences in the daily commitment of effort to professional learning (ω_b = .89) and a reliability coefficient for measuring daily fluctuations in commitment (ω_w = .93).

Daily work-related stress was measured using four items. One item referred to general work-related stress and read "Today, I felt stressed because of work". The remaining three items measured negative stress responses. These were based on the items from the state-part of the STAI with the highest loadings on the anxiety factor (van der Ploeg, 1982). Specifically, these items read "Today, I was tense because of work", "Today, I felt nervous because of work", and "Today, I worried because of work". Similar to the way daily quality of commitment was measured, a planned missing data design was employed in administering this scale. This meant that the item referring to general stress was presented on each day, while the other three items were randomized daily, so that only two items per respondent were presented. For this scale too, sliders were used that could move between values of zero (Completely not applicable to me) and 100 (Completely applicable to me). The psychometric properties of this scale for assessing trait-like differences between teachers and daily fluctuations within teachers were evaluated in the same way as the daily quality of commitment measure. This procedure resulted in a reliability coefficient of this scale for measuring between-person differences in stress (ω_b = .86) and a reliability coefficient for measuring daily fluctuations in stress (ω_w = .84).

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Data analysis

Cross-sectional Data. To test our hypothesis on the relationship between work-related stress and teachers' commitment to professional learning, we modeled the cross-sectional measure of work-related stress as a predictor of the cross-sectional measures of teachers' quality and quantity of commitment. With two outcome measures, we utilized a structural equation model (SEM) in Mplus 8.4 (Muthén & Muthén, 2017). Each construct was measured by at least three indicators, allowing us to estimate latent factors in a measurement model. After achieving acceptable fit, regressions between these factors were specified.

Model fit was evaluated using root mean square error of approximation (RMSEA) and comparative fit index (CFI). RMSEA below .05 and CFI above .95 indicated good fit (Browne & Cudeck, 1992), while RMSEA below .08 and CFI above .90 indicated acceptable fit (Hu & Bentler, 1999). Since occupational stress can differ based on gender (Spielberger & Reheiser, 1994), we controlled for gender by including it as a predictor of all latent factors.

Daily Data. We investigated the daily relationship between work-related stress and the quality and quantity of commitment to professional learning using

Dynamic Structural Equation Modeling (DSEM; McNeish & Hamaker, 2019) in Mplus 8.4. DSEM is suitable for examining the dynamic interplay between variables rather than just concurrent relationships (Hamaker et al., 2018). It assumes no mean-level growth or decline in the variables during the study period (Hamaker et al., 2018). We tested this assumption by using time (days) as a predictor in linear regressions for perceived stress, quantity, and quality of commitment. The tests showed no significant linear growth or decline for stress ($\beta = .017$, $p = .536$), quantity ($\beta = -.040$, $p = .156$), and quality ($\beta = .051$, $p = .121$), confirming the appropriateness of DSEM.

Analyses were performed on scale means used as single indicators to avoid overly complex models unsuitable for current DSEM methods with our data size (Hamaker et al., 2018). At the within-person (day-to-day) level, we examined how daily deviations in perceived stress and learning commitment from their 15-day means relate to each other. At the between-person level, we assessed whether higher mean stress scores coincided with lower mean commitment to learning (McNeish & Hamaker, 2019).

Specifically, the previous day's (t–1) perceived stress was used to predict the following day's (t) quantity and quality of commitment. For stable model convergence, the previous day's (t–1) quantity and quality of commitment were also used to predict the following day's (t) stress, despite no hypotheses for this relationship. Autoregressive effects, representing carryover effects from one day to the next (Hamaker et al., 2018), were included for each variable. The same regression structure as in the cross-sectional model was specified at the between-person level, with variables representing aggregates of teachers' daily questionnaire responses.

Since DSEM methods currently require Bayesian estimation (Hamaker et al., 2018), and due to the lack of prior research in this area, we used default diffuse priors so the data would dominate the results (Van der Schoot et al., 2021). Model convergence was assessed using the potential scale reduction (PSR) criterion, with convergence indicated by PSR values close to 1 and less than 1.05 (Gelman & Rubin, 1992). We also inspected trace plots of each parameter for non-convergence; stable convergence appears as "fat caterpillars" (Heathcote et al., 2019). We utilized 10,000 Markov chain Monte Carlo (MCMC) iterations with two chains, discarding the first half of each chain as burn-in (Hamaker et al., 2018).

3 Results

For an initial understanding of the relationship between work-related stress and teachers' commitment to professional learning, latent zero-order correlations between all measures from the cross-sectional data are presented in Table 1. These correlations are based on our measurement model, which showed

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adequate fit to the data, $\chi^2(584) = 799.347$, $p < .001$, RMSEA = .08, CFI = .90. In line with our hypotheses, work-related stress is shown to negatively relate to commitment to professional learning. This means that teachers who reported more stress, reported lower quality and quantity of commitment to professional learning.

Table 1

Cross-sectional data correlations of latent factors at the between-person level

	1.	2.
1. Work-related stress		
2. Commitment quality	-.268***	
3. Commitment quantity	-.200*	.761***

Note. * < .05, ** <.01, ***<.001

In Table 2, daily correlations show no relationship between work-related stress and daily professional learning, yet a surprising positive correlation emerges between aggregated daily stress and learning quality. In other words, teachers with higher average stress over 15 days also report higher average quality of commitment, contradicting the cross-sectional pattern. Consequently, Hypothesis 1 is only supported by cross-sectional data and rejected by the daily data, while Hypothesis 2 also remains unsupported. We next examine between-teacher and within-teacher regression models, as described in the Methods, to test these hypotheses more rigorously.

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Table 2

Daily data standardized correlations for the day to day and teacher to teacher levels

	Day to day		Teacher to teacher	
	1.	2.	1.	2.
1. Work-related stress				
2. Commitment quality	.070		.236**	
3. Commitment quantity	.044	.140*	.108	.380***

Note. * < .05, ** <.01, ***<.001

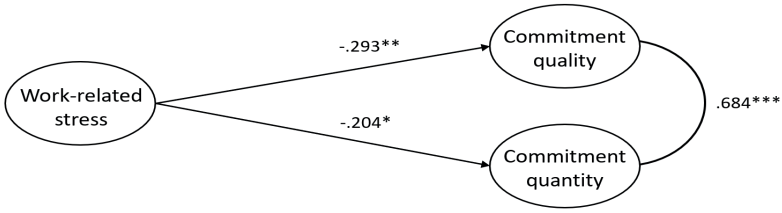
Cross-sectional data

The relationship between work-related stress and commitment to learning activities, based on the cross-sectional data, was modeled through a latent factor model. This model showed acceptable fit to the data (χ^2 (203) = 308.736, $p < .001$, RMSEA = .06, CFI = .90). The results depicted in Figure 1 show that, in

line with hypothesis 1, stress is negatively related to both quality and quantity of commitment to professional learning. Stress explained 5.6% of the variance in the commitment quality and 8.9% of the variance in commitment quantity. These results mean that teachers who reported higher overall work-related stress, reported a lower overall commitment to professional learning activities.

Figure 1

Teacher-to-teacher model based on the cross-sectional data



Note. Standardized estimates of the latent structural factor model of work-related stress and commitment to professional learning based on the cross-sectional data, controlling for gender. Significance is indicated as * < .05, ** <.01, ***<.001. For model clarity, residuals are not shown.

Daily data

The second model is based on the daily data and likewise aimed to explain the relationship between work-related stress, commitment quality, and quantity in professional learning activities, this time both from day to day and from teacher to teacher. Given the Bayesian estimation approach, model convergence was assessed by inspecting the PSR, which converged close to one for each parameter (all below <1.05). In addition, for each parameter, the trace plots were inspected. These likewise indicated stable estimations for each parameter of interest.

Teacher-to-teacher model. DSEM was used to model the between-person relationships of work-related stress (Figure 2), learning commitment quality, and quantity. Here, the results show that work-related stress significantly and positively relates to the effort teachers invest in professional learning activities. This corroborates the correlations in Table 2 and means that hypothesis 1 cannot be supported by our daily data. The relationship bares the opposite sign to what we expected for commitment quality and is not significant for commitment quantity.

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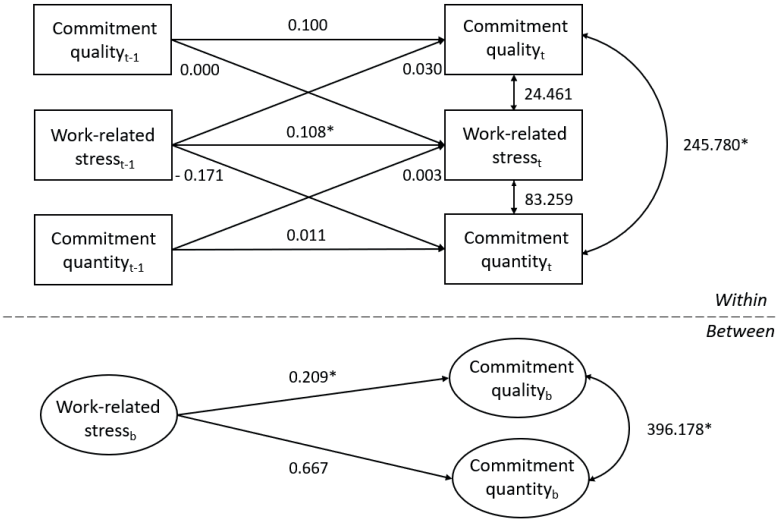
Figure 2

Day-to-day model based on the daily data



Note. Day-to-day model (with unstandardized estimates) of daily work-related stress and commitment to professional learning, with t-1 = variable at the previous day, t = variable at the following day, commitment quality = daily investment of effort, and commitment quantity = daily time spent on learning activities in minutes. Subscript 'b' denotes the same variables at the between-person (teacher to teacher) level. Superscript * indicates that 0 was not included in the Bayesian credibility intervals and that the estimate is therefore regarded as meaningful (i.e., significant).

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Day-to-day relationship and cross-lagged effects. Figure 2 shows that, on the same day, stress does not significantly relate to either the quality or quantity of professional learning, so Hypothesis 2 is unsupported. There are also no significant cross-lagged effects, meaning the previous day's stress does not affect next-day learning (rejecting Hypothesis 3).

Autoregressive effects. Stress carries over significantly from one day to the next, but no such carryover is found for learning quantity or quality. This suggests teachers' daily commitment to professional learning is more opportunistic or unstructured rather than a persistent, day-to-day pattern.

4 Discussion

This study investigated the extent to which work-related stress affects teachers' commitment to professional learning activities in terms of quality (effort) and quantity (time). We examined these relationships from both a commonly

used teacher-to-teacher perspective and a day-to-day perspective, which has received little attention in teacher learning research. We hypothesized that work-related stress (experienced as work-related anxiety) would negatively relate to the quality and quantity of teachers' commitment to professional learning activities. We expected this relationship to hold both between different teachers and within teachers from day to day. However, testing these hypotheses with cross-sectional and daily intensive longitudinal data from 151 teachers revealed conflicting results. The following sections discuss these findings in greater detail.

Implications for Theory and Research

Although we aimed to investigate stress as a clear predictor of teachers' professional learning, our findings were ambiguous. In Hypothesis 1, we expected that teachers who experience more work-related stress would report less quality and quantity of commitment to professional learning activities. The cross-sectional data supported this hypothesis: teachers who scored higher on overall work-related stress scored lower on overall commitment to professional learning, and vice versa. However, the aggregated daily data showed the opposite effect—teachers who had higher work-related stress scores on average over 15 days reported higher quality of commitment to professional learning on average.

A possible explanation for these contradictory findings is that teachers use different types of knowledge when responding to trait questionnaires compared to daily retrospective questionnaires. In the cross-sectional part of the study, teachers were asked to report on their work stress and professional learning "in general." According to Robinson and Clore (2002), individuals fill out such measures based on their identity-related beliefs, which can be idiosyncratic ("I am a stressed person") or normative ("Teaching is a stressful profession"). These beliefs can lead teachers to report high stress levels and low learning commitment simultaneously (Kyriacou, 2001; McCarthy et al., 2016). If teaching is perceived as a high-demand profession, teachers might think they have little time and effort left to commit to professional learning activities.

In contrast, daily self-reports are confined to specific days and may contain less memory bias and normative influence (Mehl et al., 2012; Robinson & Clore, 2002). Therefore, teachers who experience more stress on average from day to day might actually commit more effort to their professional learning. One reason could be that, on a daily basis, teachers feel more resilient and adaptive in their capabilities than they expect themselves to be in general. When confronted with stressful situations on a particular day, teachers may choose to address these problems directly by adopting a problem-focused coping approach instead of an avoidance strategy (Folkman et al., 1986). This goes against the notion that anxiety results from experiencing problems at work. On an average day-to-day basis, teachers may experience anxiety not solely due to

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threatened but also due to feeling challenged. As such, anxiety may correspond more with feelings of challenge, leading to increased performance rather than the expected decrease. This appears especially true when individuals expect to cope with negative experiences (Skinner & Brewer, 2002). Moreover, it is possible that teachers already engage in informal, 'on-the-spot' learning during stressful moments (reflection-in- and on-action), suggesting that stress may not only coexist with but also actively trigger short-cycle, adaptive learning processes right in the classroom.

Further supporting this explanation is the small but significant daily carryover effect of stress found in this study. Although this carryover effect was significant, it was small, indicating that only a little variance in a teacher's stress on a given day is explained by stress experiences of the previous day. This could suggest that the time scale on which teachers deal with stress is smaller than daily. Research indicates that work-related anxiety for teachers is a relatively short-lived emotional experience, varying multiple times a day (Keller et al., 2014). If stress fluctuates more rapidly than daily measures capture, it would explain the low carryover effect. Future research may benefit from using shorter intervals, such as hour-to-hour stress assessments, or incorporating biological markers like heart-rate data (Junker et al., 2021), skin conductivity, or cortisol levels (Burnard et al., 2016; Korpal, 2016).

For Hypothesis 2, no same-day daily relationship was found between stress and commitment to professional learning, and the same reasoning regarding differences in appropriate time frames applies. Commitment to professional learning may be more sporadic and occur over longer periods, making it less suitable for daily measurement. Learning may also occur over time, with daily experiences contributing to larger, more defined learning goals. Therefore, the commitment to professional learning is likely not suitably captured by the daily time frame.

Similarly, for Hypothesis 3, work-related stress may be unable to predict commitment to professional learning of the following day due to differences in the pace at which stress and professional learning change from day to day. As the time scale for a variable increases, its power to predict itself or other variables at later occasions decreases exponentially (Kuiper & Ryan, 2018; Lai & Lu, 2017). If work-related stress fluctuates more rapidly than daily measurements can capture, it would explain why it was unable to predict commitment to learning at a later time point.

These findings imply that this study took an important first step into exploring appropriate time frames for studying work-related stress and professional learning among teachers. In other disciplines like physics, chemistry, and biology, considerable care is given to finding appropriate intervals before setting up large-scale research. However, in the social sciences, we often rely on convention and convenience (Cole & Maxwell, 2003). Future

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research should give considerable attention to finding and choosing the appropriate time frame for each construct under investigation. Starting with closely spaced intervals and many consecutive measures can reduce the chance of missing relevant fluctuations, as data can always be aggregated to create larger intervals but cannot be disaggregated to smaller ones.

Limitations

In addition to the limitation of the time scales chosen for this study, other limitations need to be considered. First, unmotivated and highly stressed individuals may be less inclined to participate in research, potentially underrepresenting the most stressed teachers and underestimating stress effects. This could mean that the effects of stress appear smaller than expected based on reports of high stress and burnout in the population. Future researchers should find innovative approaches to include this important part of the research population. For example, in agreement with school boards, all teachers could be allotted time for participating in the research, reducing the burden or additional stress that participation may cause.

Second, the mixed findings suggest that a day-to-day perspective may be too coarse to detect immediate effects of stress on professional learning. Teachers' stress can fluctuate substantially within a single day—sometimes even from lesson to lesson (see Keller et al., 2014)—and these within-day stressors might trigger micro-learning moments (brief reflection-in-action or on-the-spot instructional changes) that do not necessarily spill over into the next day. Consistent with this, our findings showed only minimal carryover of stress from one day to the next, making it unlikely that yesterday's stress would substantially alter today's professional learning efforts. Future research would therefore benefit from a finer-grained, within-day approach—such as repeated measurements or short digital reflections throughout the school day—to capture the nuanced ways that transient stress experiences might shape teachers' learning and development.

Relatedly**,** as noted earlier, one challenge in this study was capturing the full range of teachers' informal, on-the-spot learning activities. Future research would benefit from more concrete and context-specific measures of professional learning. For instance, short reflective logs or teaching journals could be used to document micro-learning incidents immediately after they occur. Another approach might involve direct classroom observations or video recordings followed by structured debriefing sessions, enabling researchers to capture and code in-situ learning moments (e.g., when teachers adapt lesson content mid-class in response to student needs). Furthermore, fine-grained digital tools—such as mobile apps that prompt teachers to log brief reflections—could offer deeper insights into the short-cycle learning that occurs throughout the school day. By integrating these richer measurement strategies, researchers

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can more accurately identify and quantify how and when teachers learn, thus providing stronger empirical grounding for interventions designed to foster professional growth.

Fourth, although stress may fluctuate more rapidly than daily, teachers often completed the questionnaire in the evening, potentially introducing recall bias. Our custom software did not record timestamps, but we asked participants to respond on the same day to minimize memory decay. While future studies could benefit from more granular timing data, we remain confident that our approach adequately captured teachers' day-to-day experiences.

Finally, learning is sometimes invisible; people may take their learning for granted or not recognize the activity as learning. Knowledge gained is often regarded as part of a person's general capability rather than a result of personal growth (Eraut, 2004). This poses a dilemma because formal learning might be too externally regulated to be recognized as a personal commitment, while informal learning can be so interwoven with daily activities that it goes unnoticed by the learner. This makes it challenging to capture individuals' learning commitment and behaviors solely through self-report questionnaires. Future research may want to supplement self-reports with expert observations or investigate more specific operationalizations of professional learning to reduce uncertainty participants may have regarding their learning activities.

Implications for Practice

First, school leaders and policymakers could use these insights to design more flexible professional development (PD) opportunities. Instead of relying solely on structured, one-size-fits-all workshops scheduled far in advance, schools might offer shorter, more frequent, and easily accessible PD sessions that teachers can choose to engage in on days when they feel more capable and motivated—despite or even partly because of experiencing stress. Regular check-ins or modular PD opportunities accessible online may help teachers commit meaningful time and effort when it best fits their day-to-day circumstances.

Second, the findings highlight the importance of addressing normative beliefs about the teaching profession. Interventions aimed at reshaping teachers' perceptions that stress necessarily hinders learning could help teachers embrace adaptive coping strategies. For instance, coaching sessions, peer support networks, or reflection groups can guide teachers to reinterpret stress-inducing events as challenges that, in some cases, can fuel their learning and professional growth. Providing teachers with tools to recognize and leverage small windows of opportunity for learning—such as micro-reflections at the end of a stressful teaching day—may help maintain their PD trajectory over the long term.

5 Conclusion

This study highlights the complexity of how teachers' work-related stress interacts with their commitment to professional learning, revealing that such relationships can differ greatly depending on whether data are collected cross-sectionally or daily. While general (cross-sectional) perceptions suggest that stress undermines engagement in professional development, daily patterns show that stress does not always reduce, and may sometimes align with, efforts to learn. These mixed results raise questions about the role of broader beliefs regarding the difficulty of teaching, as well as the importance of choosing the right time frames for measuring both stress and learning activities.

Contrary to conventional assumptions, our findings suggest that stress does not inevitably impede teachers' professional learning. Instead, it appears that daily stress experiences are relatively short-lived and do not easily carry over to the following day. Yet this does not diminish the reality that stress remains a significant problem for teachers worldwide.

In practical terms, these insights indicate a need for interventions aimed at reshaping teachers' normative beliefs about the teaching profession. By viewing some stressors as challenges rather than threats, schools and policymakers can foster an environment that encourages problem-solving, resilience, and adaptive engagement in professional learning. Recognizing the dynamic, fluctuating nature of teacher stress can guide more flexible professional development opportunities, making it easier for teachers to engage when it suits their daily circumstances. Future research should continue to examine the appropriate timescales for capturing the fast-paced nature of stress and better support teachers in navigating their professional growth.

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Appendix – Questionnaire items

Below in appendix A the 'trait' items that were used to collect the cross-sectional data can be found. In appendix B the 'state' items that were used in the daily questionnaire are shown. See the method section for more details on how these instruments were implemented.

Appendix A: Trait items (cross-sectional instrument)

ORIGINAL DUTCH ITEMS

Construct 1: Quantity of investment in professional learning (Dutch)

Options:	**Vrijwel nooit (1) – Vaak (5)**
1.	Vakinhoudelijke literatuur bestuderen
2.	Bezoeken van onderwijskundige sites op internet
3.	Onderwijskundige/vakdidactische literatuur lezen
4.	Deelnemen aan een studiedag/conferentie waarin vakdidactiek centraal staat
5.	Deelnemen aan een cursus waarin vakdidactiek centraal staat
6.	Nieuwe werkvormen uitproberen in mijn les
7.	Uitproberen van nieuwe ICT toepassingen in mijn les
8.	Alternatieve lesmaterialen uitproberen in mijn klas
9.	Nieuwe vormen van beoordelingen toepassen en evalueren
10.	Onderzoek doen naar nieuwe werkvormen in mijn klas
11.	Aan leerlingen vragen wat ze vinden van mijn manier van lesgeven
12.	Mijzelf evalueren op goede en zwakke punten
13.	Collega's uitnodigen mijn les bij te wonen
14.	Mijn lesaanpak aanpassen naar aanleiding van reacties van leerlingen
	Met collega's…
15.	…praten over de manier waarop ik dingen aanpak in de klas
16.	…de lessen voorbereiden
17.	…afspraken maken over de didactische werkwijze
18.	…discussiëren over verbetering en vernieuwing van het onderwijs op mijn school
19.	…nadenken over de opzet en werkwijze van leerlingbegeleiding
20.	…een werkgroep of commissie vormen op school
21.	…een mening geven aan de schoolleiding over school-organisatorische zaken

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Construct 2: Quality of investment in professional learning (Dutch)

Options:	(Bijna) nooit (1) – (Bijna) altijd (5)
1.	Ik begin uit mezelf aan professionele leeractiviteiten
2.	Bij het ondernemen van professionele leeractiviteiten werk ik aan een stuk door
3.	Ik doe zo weinig mogelijk aan professioneel leren
4.	Ik werk hard aan mijn professionele leren
5.	Tijdens mijn professionele leeractiviteiten doe ik allerlei dingen tussendoor
6.	Ik laat mijn professionele leren liggen
7.	Ik kan moeilijk uit mezelf aan mijn professionele leeractiviteiten beginnen

Construct 3: Experience of stress at work (Dutch)

Options:	**(Bijna) nooit (1) – (Bijna) altijd (5)**
	Als ik aan het werk ben…
1.	…voel ik me prettig
2.	…voel ik me nerveus en onrustig
3.	…voel ik me tevreden
4.	…kan ik een tegenslag moeilijk verwerken
5.	…voel ik me in vrijwel alles tekort schieten
6.	…voel ik me uitgerust
7.	…voel ik me rustig en beheerst
8.	…voel ik dat de moeilijkheden zich opstapelen zodat ik er niet meer tegenop kan
9.	…pieker ik teveel over de dingen die niet zo belangrijk zijn
10.	…ben ik gelukkig
11.	…word ik geplaagd door storende gedachten
12.	…heb ik een gebrek aan zelfvertrouwen
13.	…voel ik me veilig
14.	…voel ik me op mijn gemak
15.	…ben ik gelijkmatig van stemming
16.	…ben ik tevreden
17.	…zijn er gedachten die ik heel moeilijk kan loslaten
18.	…neem ik teleurstellingen zo zwaar op dat ik ze niet van me af kan zetten
19.	…ben ik een rustig iemand
20.	…raak ik helemaal gespannen en in beroering als ik denk aan mijn zorgen van de laatste tijd

TRANSLATED ENGLISH ITEMS

Construct 1: Quantity of investment in professional learning (English translation)

Options:	**Almost never (1) – Often (5)**
1.	Studying subject-related literature
2.	Visiting educational websites
3.	Reading pedagogical or subject-methodology literature
4.	Attending a study day/conference focusing on subject methodology
5.	Attending a course focusing on subject methodology
6.	Trying new teaching methods in my lesson
7.	Trying new ICT applications in my lesson
8.	Trying alternative lesson materials in my classroom
9.	Implementing and evaluating new forms of assessment
10.	Conducting research on new teaching methods in my class
11.	Asking students what they think of my teaching style
12.	Evaluating my strengths and weaknesses
13.	Inviting colleagues to observe my lesson
14.	Adapting my lesson approach based on student feedback
	With colleagues, I…
15.	…talk about how I handle things in class
16.	…prepare lessons
17.	…set agreements on the didactic approach
18.	…discuss improvements and innovations in education at my school
19.	…consider approaches and methods for student guidance
20.	…form a working group or committee at school
21.	…share my opinions on organizational matters with school leadership

Construct 2: Quality of investment in professional learning (English translation)

Options:	(Almost) never (1) - (Almost) always (5)
1.	I start professional learning activities on my own initiative
2.	When I engage in professional learning activities, I keep working continuously
3.	I do as little as possible for my professional learning
4.	I work hard on my professional learning
5.	While undertaking professional learning activities, I do various other things in between
6.	I leave my professional learning tasks unattended
7.	I find it difficult to start my professional learning activities on my own

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Construct 3: Experience of stress at work (English translation)

Options:	**(Almost) never (1) - (Almost) always (5)**
	When I'm at work...
1.	...I feel good
2.	...I feel nervous and uneasy
3.	...I feel satisfied
4.	...I find it hard to cope with setbacks
5.	...I feel I'm falling short in almost everything
6.	...I feel rested
7.	...I feel calm and in control
8.	...I sense difficulties piling up until I can no longer handle them
9.	...I worry too much about unimportant things
10.	...I am happy
11.	...I am bothered by disturbing thoughts
12.	...I lack self-confidence
13.	...I feel safe
14.	...I feel at ease
15.	...I have a steady mood
16.	...I am content
17.	...certain thoughts are very hard for me to let go
18.	...I take disappointments so hard that I cannot put them aside
19.	...I am a calm person
20.	...I become tense and upset when I think of my recent worries

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Appendix B: State items (daily instrument)

ORIGINAL DUTCH ITEMS

Construct and item number	Items
Construct 1: Quantity of learning	
1	Hoe lang hebt u vandaag besteed aan professionele leeractiviteiten in minuten (lezen, reflecteren, experimenteren, samenwerken, cursussen, workshops, trainingen, etc.)?
Construct 2: Quality of investment in learning	
Vandaag heb ik … … tijdens mijn professionele leren	
1	mij ingespannen
2	moeite gedaan
3	hard gewerkt
4	mij flink ingezet
	Vandaag was ik … bezig met mijn professionele leren
5	gefocust
6	Volhoudend
Construct 3: Stress at work	
Vandaag … … door mijn werk	
1	was ik gespannen
2	voelde ik me nerveus
3	voelde ik mij gestrest
4	maakte ik mij zorgen

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TRANSLATED ENGLISH ITEMS

Construct and item number	Items
Construct 1: Quantity of learning	
1	How many minutes did you spend today on professional learning activities (reading, reflecting, experimenting, collaborating, courses, workshops, training, etc.)?
Construct 2: Quality of investment in learning	
	Today, during my professional learning, I …
1	put in effort
2	exerted myself
3	worked hard
4	applied myself fully
	Today, I was … in my professional learning
5	focused
6	persistent
Construct 3: Stress at work	
	Today, because of my work, I …
1	was tense
2	felt nervous
3	felt stressed
4	was worried

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Samenvatting

Stress en Professionele Ontwikkeling van Leraren: Van Dag-tot-Dag en van Leraar-tot-Leraar

Om mee te gaan met snelle maatschappelijke veranderingen, moeten leraren zich voortdurend professioneel blijven ontwikkelen. Tegelijkertijd ervaren zij vaak werkgerelateerde stress, wat hun inzet voor professionele ontwikkeling kan beïnvloeden. In dit onderzoek is met behulp van dagelijkse metingen (gedurende 15 werkdagen bij 151 middelbare schoolleraren) nagegaan hoe werkgerelateerde stress samenhangt met zowel de kwaliteit als de kwantiteit van leraren hun inzet voor professionele ontwikkelingsactiviteiten. Op basis van de literatuur werd verwacht dat hogere stress gepaard zou gaan met minder toewijding aan deze activiteiten, zowel tussen verschillende leraren als van dag tot dag. De resultaten bleken echter deels tegenstrijdig. Op basis van eenmalige (cross-sectionele) metingen leek stress inderdaad de professionele ontwikkeling te beperken. De dagelijkse metingen lieten echter zien dat stress niet altijd een rem hoefde te vormen; soms kon deze juist samenvallen met een grotere inzet. Zo ontstaat een genuanceerder beeld: algemene opvattingen over het lerarenberoep en tijdsvensters waarin stress en leren plaatsvinden spelen een rol bij het begrijpen van de relatie tussen stress en professionele ontwikkeling. Deze bevindingen onderstrepen het belang van een zorgvuldige keuze van meetmomenten en wijzen erop dat stress, afhankelijk van de context, zowel belemmerend als stimulerend kan zijn voor professionele groei.

Kernwoorden professionele ontwikkeling van leraren, werkgerelateerde stress, dagelijkse metingen

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