

What makes a good study day? An intraindividual study on university students' time investment by means of time-series analyses

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ABSTRACT

University students often claim to have problems managing the time required to carry out their study demands successfully, which leads to discontent. The question is how much time do students really invest in their studies, what changes occur in time investment over a full academic term, and finally, how is study time related with students' daily study satisfaction? Daily time-series data taken from 105 university students over 154 days were analyzed by means of process analysis techniques and multilevel analysis. The learning time trajectories show a quadratic trend in independent study time and a linear decrease in lecture time. Students' daily study satisfaction was positively related to time investment, but even more strongly to planning, effort, and procrastination. Usage of breaks between lectures was found to be an independent predictor of learning satisfaction. These results have practical implications for increasing students' learning satisfaction beyond the impact of pure time investment.

1. Introduction

Many students claim that they have too much to do and too little time in which to get everything done, leading them to become discouraged (Schulmeister & Metzger, 2011). In the workplace, individuals are typically required to invest a specific, pre-defined amount of time for which they are paid (e.g., 40 h a week). Similarly, in the European Union, the Bologna Process (European Union, 2015) provides a framework for university students' expected time investment. For bachelor's and master's degrees, students are expected to invest 40 h per week to complete their studies within the standard degree period. However, the question remains whether these subjective views of time investment correspond to objective measures. The present study attempts to investigate the time students actually spend objectively on their studies, how time investment develops over the course of a whole term, and as a main theme how students' time investment is related to their daily study satisfaction. Time investment—being a facet of self-regulated learning (SRL) in our theoretical model (Schmitz & Wiese, 2006)—is put into focus in the present study, comparing its influence to several other SRL facets.

1.1. Relevance of time investment

Time—which students can potentially invest in a learning

setting—is often addressed in educational psychology research when attempting to predict students' learning outcomes. Several models of teaching and learning time in school contexts have emphasized the importance of time investment (e.g., Bennett, 1978; Bloom, 1976; Harnischfeger & Wiley, 1976; Schmitz & Wiese, 2006) and include, for example, time spent on homework as a predictor of academic achievement.

Schulmeister and Metzger (2011) studied time investment in bachelor's studies from six German universities; however, they investigated only one term in one academic major in each of the six universities. They used diaries in the form of calendar entries to measure time investment and found that students invested an average of 24 h per week in their learning activities. This result is surprising in light of current debates regarding supposedly unreasonably high academic workloads attributed to the adoption of the bachelor's and master's system. As most studies on time investment and in particular its relation to other outcome variables of interest (e.g., performance) have only investigated a short and specific time period, our knowledge about students' methods and course of time investment is very scant.

1.2. The measurement challenge of time investment

One important challenge researchers face when conducting research regarding students' time investment and other variables directly

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associated with it is the measurement of those variables as state measures. In the past, several studies have examined the impact of time on certain variables. Some studies have measured time only as the average number of minutes that students invest in completing specific homework assignments (e.g., Keith, 1982; Trautwein & Lüdtke, 2007). Others have measured time by asking students to rate their time investments using a range of options from less than 1 h per week to more than 15 h per week (e.g., Keith & Cool, 1992). These forms of time measurement have been shown to be biased. Thus, the retrospective assessment of time can be criticized with respect to its ecological validity. Several other studies have also concluded that retrospective assessments of time investment in learning over longer periods are biased (De Jong, Westerhof, & Creemers, 2000). Therefore, many researchers advocate the assessment of time investment by using daily diaries (Fuller et al., 2003).

One example of measuring time investment in a non-retrospective way can be seen in the study of Plant, Ericsson, Hill, and Asberg (2005). They measured time investment during one week by means of a daily time log (i.e., students were asked to note their activities in 15-min intervals: studying, sleeping, etc.). Nevertheless, they only observed one week out of an entire term. As university requirements vary over the course of the term, one week can hardly be a sufficient basis for general conclusions about students' time investment.

Research applying adequate methods such as process analysis to measure time-related characteristics among university students is still required to understand not only how much time, on average, students invest in their learning but also whether trends or patterns are observable over time. To investigate these issues, Schmitz (2006) advocates the use of process analysis because it enables one to study both individual and aggregated trajectories of learning over time (e.g., trends and patterns). As trends, rhythms, and other imbalances likely occur over the period of one term, these methods seem to be mandatory for obtaining a clear picture of what is happening in students' lives at universities.

1.3. Trajectories of time investment

The time that university students invest in their learning process can be divided into two basic components: 1) time spent at lectures and 2) independent study time (Meng & Heijke, 2005).

Time invested in lectures normally decreases over the course of a term for several reasons. First, students may increasingly feel that they do not learn enough from the lecture as the content increases in complexity over the course of the term. Second, the time that was previously invested in attending a lecture may later be used instead for independent study if students feel that they have understood the lecturer's expectations regarding their learning and that they can better meet those expectations through independent study. Thus, we hypothesize that the aggregated time invested (over students) in lectures will decrease over the course of the term in a linear manner. Independent study typically increases as examination dates approach and, naturally, decreases dramatically after examinations have been completed (Schmitz & Wiese, 1999). As most examinations take place within the first week of the non-lecture period, we hypothesize that independent study time increases until that point and decreases thereafter, resulting in a negative quadratic trend over the time span of our survey. In addition, because lectures typically take place during the workweek, we expect to observe a weekly pattern concerning time invested in lectures. That is, weekends will likely be associated with the lowest investments in lecture time. In the case of time invested in independent study, we also expect to observe a weekly pattern, as many students participate in other activities on weekends, thus leaving less time for independent study than during the week.

1.4. Connection between time investment and daily study satisfaction

A theoretical model that combines the importance of time investment with other psychological variables related to successful learning is the process model of self-regulated learning (SRL) proposed by Schmitz and Wiese (2006). This model is based on the conception of self-regulated learning by Zimmerman (2000). Schmitz and Wiese's (2006) model states that successful learning requires the management of time, not only through mere time investment, but also through goal-directed planning of time investment before and reflection of time investment after studying. According to this model, learning is regarded as a cyclical sequence of states that can be assigned to three phases. In the preaction phase, the learner is involved in planning his/her learning episode on the basis of individual goal setting. According to the model, the time plan should also include learning breaks as a strategy of time management. The action phase is when the learner actually handles the learning material. In this phase, the quantitative amount of time investment is considered important. For this purpose, the learner needs to avoid procrastination. However, the quality of time investment is also crucial, as determined by the exertion of effort and the choice of adequate learning strategies. In the postaction phase, the learner reflects on his/her learning. As objective learning success is often not easy for learners to estimate, subjective satisfaction with learning is considered the central dependent variable.

1.5. Predictors of students' daily study satisfaction

The present study investigates the intraindividual processes that can predict students' daily study satisfaction. What makes a good study day in the eyes of a student? This is the second question that the present study aims to answer. There are many things students must do during a study day, and it is not only the amount of time invested that determines the success or otherwise of such a day. Imagine two students, both of whom spend the whole day at the university campus and both reflecting on their day in the minute before they go to bed. One is satisfied with what he/she has achieved (study-relevant) on this day; the other is not. What has caused the difference between these two students?

We investigate the most pressing variable, time, and those variables that are directly associated with students' time investment. Based on the process model of SRL (Schmitz & Wiese, 2006), we included variables from all three phases in our study, whereas the variable in the post-action phase (satisfaction) is our dependent variable: planning, time investment (divided into lecture time, independent study time, and using breaks for independent study), procrastination, and effort. In the following section, we provide a brief overview of how these variables should influence students' daily study satisfaction.

1.5.1. Time investment

No student can achieve anything without using time. The more time students spend on study-relevant material, be it at a lecture or through independent study, the more they can potentially achieve in one day. The impact of time on academic achievement (e.g., grades) has already been studied in the past, and research has found strong evidence of its impact (Plant et al., 2005). Thus, we suggest that both lecture- and independent study time have a positive linear relationship with students' daily study satisfaction.

A special aspect of independent study time—using breaks for independent study—seems to have been neglected by the research so far. However, we consider it to have the potential to explain students' misconceptions about their own time investment. At universities, it is not unusual for students to have breaks of one or more hours between one lecture and another on the same day. Therefore, students must decide how to spend this time. Being together with fellow students, one possibility is to decide to spend time with them, just talking, drinking coffee, having a nap, browsing the Internet, etc. Another possibility is to

use this time for independent study (e.g., learning, preparing a presentation, or writing a homework assignment). Time spent relaxing or talking to fellow students can undoubtedly be refreshing, but time used for independent study offers much more potential for achieving study-relevant goals in one's day, just like lecture- and independent study time per se. Therefore, we suggest a positive linear relation between using breaks for independent study and students' daily study satisfaction.

1.5.2. Planning

Planning is one of several components of meta-cognitive strategies (Pintrich, Smith, Garcia, & McKeachie, 1993). Self-reported metacognition has been found to be positively correlated with achievement at the end of the term (Pokay & Blumenfeld, 1990).

Planning can contain various aspects. As our focus is on time investment, we refer to having a specific plan according to which a student will perform his/her daily study-related tasks. Planning one's tasks enables students to be more focused and to concentrate in the face of distracting thoughts (Veenman, Van Hout-Wolters, & Afflerbach, 2006). Having no plan, on the other hand, will probably send one off course. Therefore, we suggest that planning is positively related to students' daily study satisfaction.

1.5.3. Procrastination

Procrastination is the tendency to postpone an activity one is supposed or even wants to do, but failing to perform the task due to feelings of discomfort (Howell & Watson, 2007; Senecal, Koestner, & Vallerand, 1995; Solomon & Rothblum, 1984; Wolters, 2003). Procrastination is viewed as a maladaptive behavior (Wolters, 2003) because it reduces students' time for working properly on their planned tasks. Even though Wolters (2003) suggests that planning (or lack thereof) might explain the tendency to procrastinate, this explanation is not adequate, as, by definition, procrastination also means not doing a task although it has been planned. Wolters (2003) found a correlation coefficient of -0.33 and Howell and Watson (2007) a correlation coefficient of -0.40 for the relation between procrastination and metacognitive strategies. Schouwenburg (2004) also showed that procrastination is inversely correlated with planning and managing one's time. Meta-analyses (Richardson, Bond, & Abraham, 2012; van Eerde, 2003) have revealed a weak significant relation with performance. Finally, procrastination has been linked with negative affective outcomes, like higher levels of depression and lower levels of self-esteem (Lay & Schouwenburg, 1993; Lay, 1992; Martin, Flett, Hewitt, Krames, & Szanto, 1996). Against this background, we suggest that procrastination is inversely related with students' daily study satisfaction.

1.5.4. Effort

While some researchers define effort as the amount of time used (e.g., Dweck, 1986; Steinberg, 1989), in his definition, Carbonaro (2005) additionally takes into account the amount of energy spent. This definition includes the possibility that individuals may invest a specific amount of time in a task, but their focus lies elsewhere. In addition, he contrasted effort with other similar or related concepts (resistance, motivation, self-efficacy, and engagement), concluding that effort is different because it can affect outcomes regardless of these concepts. For the present study, we refer to the definition of effort provided by Fisher and Ford (1998): the "amount of cognitive, attentional resources devoted to the learning task" (p. 403). This definition does not include time investment, thereby enabling us to measure effort and time investment separately. Effort has been shown to be related with positive (including affective) outcomes (e.g., GPA and pride; Wentzel, 1989; Jagacinski & Nicholls, 1984; 1987) and inversely related with negative affective outcomes (e.g., guilt; Jagacinski & Nicholls, 1984; 1987). Thus, we suggest that effort, too, is positively related to students' daily study satisfaction.

1.6. Hypotheses

In conclusion, we derive the following hypotheses:

Hypothesis 1. Lecture time and independent study time are both positively related to students' daily study satisfaction.

Hypothesis 2. Using breaks for independent study is positively related to students' daily study satisfaction, above and beyond the impact of lecture- and independent study time.

Hypothesis 3. Planning is positively related to students' daily study satisfaction, above and beyond the impact of lecture- and independent study time, and using breaks for independent study.

Hypothesis 4. Procrastination is negatively related to students' daily study satisfaction, above and beyond the impact of lecture- and independent study time, using breaks for independent study, and planning.

Hypothesis 5. Effort is positively related to students' daily study satisfaction, above and beyond the impact of lecture- and independent study time, using breaks for independent study, planning, and procrastination.

2. Method

2.1. Participants

The participants were bachelor's- and master's-level students from various academic terms and departments of a technical university in Germany. Participation in the study was voluntary. Participants were recruited by means of flyer and poster advertising throughout the campus, and information material was distributed to lecturers to present in their lectures within the first two weeks of the lecture period. A total of 554 students responded to the initial questionnaire. Of these, 232 began the daily questionnaire. One hundred and five participants, who also completed the survey at the end of the term, reached our cut-off value of a minimum of 80% participation throughout the daily survey period, constituted our final sample. On average the students responded to 136 of 154 (88%) measurements.

2.1.1. Dropout analyses

Dropouts did not differ significantly from the final sample of 105 participants in terms of sex ($t(223.19) = -0.51$, $p > 0.05$, Cohen's $d = 0.08$), term ($t(202.90) = -0.75$, $p > 0.05$, Cohen's $d = 0.10$), general study satisfaction ($t(223.25) = 1.35$, $p > 0.05$, Cohen's $d = 0.18$), and general study load ($t(209.47) = -0.99$, $p > 0.05$, Cohen's $d = 0.13$). However, the two groups differed significantly in age ($t(202.52) = -2.78$, $p < 0.05$, Cohen's $d = 0.37$): participants who dropped out were significantly younger ($M = 22.37$) than finishers ($M = 23.33$). The two groups also differed significantly in their goals regarding how many credit points they wanted to reach in the present term ($t(225.10) = 2.37$, $p < 0.05$, Cohen's $d = 0.31$): participants who dropped out had a significantly higher goal ($M = 32.92$), than finishers ($M = 30.54$). We also tested whether the dropouts and finishers significantly differed in terms of their time investment in lectures or independent study within the first two weeks of the survey period. They did not differ according to the time they spent in lectures ($t(209.43) = 0.33$, $p > 0.05$, Cohen's $d = 0.04$) nor did they differ in terms of the time they spent on independent study ($t(193.05) = -1.13$, $p > 0.05$, Cohen's $d = 0.15$).

2.1.2. Characteristics of the final sample

The mean age of the final sample of 105 participants was 22.32 years ($SD = 2.81$); mean number of terms was 4.39 ($SD = 2.68$). Thirty-nine of the participants were female. This proportion of men and women is typical for technical universities in Germany. Sixty-six of the

students were undergraduates (62.86%). Seventy participants were studying engineer sciences (66.67%), 16 natural sciences (15.23%), 9 were studying for a teaching certification (8.57%), and 10 were studying humanities (9.52%). Participants came from 40 different majors, 24 different majors in undergraduate studies, and 16 different majors in graduate studies. Twenty-nine participants did not work at all throughout the entire term (27.62%), 44 worked fewer than 5 h per week, but more than zero hours on average (41.09%), 23 worked between five and 10 h per week (21.90%), and nine participants spent more than 10 h working per week (8.57%).

2.2. Procedure

At the beginning of the term's lecture period, students were given two weeks to take part in the initial survey. These two weeks were used to recruit participants for this study. Participants responded online to a survey, giving information about their age, current term, academic major, overall study satisfaction, overall study load, and certain other variables, some of which are described later. Only students who completed the survey within that time period were given the opportunity to participate in the daily survey throughout the term.

The online daily diary survey began at the beginning of the third week of the lecture period. Each student had a personal, password-protected account in which they entered their data daily until the end of the term five months later (a total of 22 weeks: 12 weeks of lecture period and 10 weeks of non-lecture period). Diary entries could be made online using a personal computer, laptop, smartphone, or smartphone app. Thus, a prompt record of daily study time as well as other daily items could be provided. Participants could enter any time investment at any time until 5 p.m. on the following day (this limitation was set to minimize biases associated with retrospective responding). Time investment was assessed individually for lectures and independent study. In addition, students were asked to report the specific course in which they had invested time. Lecture time was described as the time in which students spent attending lectures. Independent study time was defined as time used for study outside lectures (i.e., preparation for lectures, studying for exams, completing homework, preparation of presentations, and working on projects).

The other daily items that are relevant for this study (i.e., time goals for lecture- and independent study time, planning, procrastination, and effort) were also assessed using the learning diary. Items relevant before learning (time goals and planning) were assessed in the morning questionnaire (from 5 a.m. to 3 p.m.), whereas items relevant after the learning (procrastination and effort) were assessed in the evening questionnaire (from 7 p.m. to 3 a.m.).

In the final two weeks of the daily diary period (approximately five months after the initial survey), participants were asked to answer a final evaluation, in which they answered several items that were used to validate the daily questionnaires, and were asked to reflect on what they had learned about their learning behavior. After the daily diary period had concluded, we computed participation rates for each participant and provided compensation to those who had reached the 80 percent quota (€100 per participant).

2.3. Instruments

2.3.1. Initial survey

Study satisfaction. Students' overall satisfaction with their study was assessed via a five-item scale from Baumert et al. (2009), which was modified for the present study. Each item was rated on a six-point Likert-scale ranging from 1 (Strongly Disagree) to 6 (Strongly Agree). Example items are, "I am very satisfied with my studies", and "For me, there is no better subject/field of study".

Study load. Students' overall study load was also assessed via a five-item scale from Baumert et al. (2009), which was modified for the present study. Each item was rated on a six-point Likert-scale ranging

from 1 (Strongly Disagree) to 6 (Strongly Agree). Example items are, "I often feel exhausted during my studies", and "Overall, I feel overloaded".

Credit points goal. Students were asked how many credit points they aimed to achieve during this term.

Demographic data. In the demographic section of the initial survey, participants reported their age, major, and number of terms at university.

2.3.2. Daily learning diary

Time variables were measured in minutes. Other variables were measured on a six-point Likert scale ranging from "not at all" to "to a great extent."

For all daily learning diary and time items, stability analyses were conducted as reliability measures. The computation adhered to recommendations by Watson (1988) and Schmitz and Skinner (1993). First, we computed separate means for the first and second half of the diary days (days 1–77 vs. days 78–154) for the respective time variables (i.e., intended lecture time, intended independent study time, lecture time, independent study time, using breaks for independent study, planning, procrastination, and effort). Second, we correlated those means across participants. The split-half coefficient for each variable is reported in parentheses in Table 1. In addition, validity coefficients had been computed for each diary variable for which a corresponding trait variable existed (see section 3.4 Final Evaluation). These coefficients are also reported in Table 1.

Intended lecture- and independent study time. The learning diary, which had to be filled out at the beginning of the study day, asked students to indicate how much time (in minutes) they aimed to spend on lectures and independent study, respectively. This information was later used as control variables in the multilevel model.

Lecture- and independent study time. Students could enter each type of time investment into their learning diary. They were asked which type of time investment (i.e., lecture time or independent study time) they wanted to record and how many minutes. The overall time investment in lectures and for independent study was later computed and was not in the hands of the students.

Using breaks for independent study. Whether students used breaks between lectures for independent study was assessed via the following item: "How much time did you spend on independent study during lecture breaks (in minutes)?"

Working time. Whether students worked that day was assessed via the following item: "How much time did you spend working for payment (in minutes)?" This variable was assessed to give additional demographic information about the study sample.

SRL Items. The learning diary contained SRL items on planning ("I have a specific plan, according to which I will perform today's study-related tasks"), procrastination ("Today, I have postponed unpleasant things"), effort ("Today, I made an effort"), and daily study satisfaction ("I am very satisfied with what I have achieved today (study relevant)"). Planning was assessed in the morning questionnaire; the other variables were assessed in the evening questionnaire. Variables were measured on a six-point Likert scale ranging from "not at all" to "to a great extent."

Missing data. Our sample consisted of 105 participants. The observation period lasted 22 weeks (=154 days). Therefore, the maximum value that could be obtained for each of the six diary variables was $105 \times 154 = 16,170$. Missing data ranged between 13% and 22% ($M = 16.10$, $SD = 0.03$) for the six variables. For the analyses presented below, we did not impute the missing data.

2.3.3. Final evaluation

To validate the diary data, we conducted a cross-sectional survey of the participants on the same or very similar variables we used in the diary. Variables were measured on a six-point Likert scale ranging from "not at all" to "to a great extent."

Table 1
Means, standard deviations, intercorrelations, and reliabilities.

Variables	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 Study satisfaction	4.43	1.01	(0.81)															
2 Study load	3.68	1.00	-0.27	(0.77)														
3 Credit point goal for the current term	30.54	7.40	-0.08	-0.21	–													
4 Undergraduate (1)/graduate (2)	1.31	0.46	-0.12	-0.06	-0.09	–												
5 Time management/planning	3.36	1.23	-0.07	0.02	0.15	-0.16	(0.84)											
6 Procrastination	3.25	1.11	-0.12	0.08	0.18	-0.05	-0.32	(0.81)										
7 Avoiding effort	2.75	0.90	0.03	0.04	-0.13	-0.08	-0.22	0.57	(0.68)									
8 Intended lecture time (hours) ^a	1.05	2.08	0.06	0.06	0.14	-0.09	-0.02	0.20	0.10	(0.53)								
9 Intended independent study time (hours) ^a	2.71	2.56	-0.15	0.15	0.14	0.17	-0.17	0.08	0.05	-0.06	(0.76)							
10 Lecture time (hours) ^a	0.70	1.65	-0.06	0.15	0.19	-0.06	-0.05	0.11	0.02	0.89	-0.35	(0.44)						
11 Independent study time (hours) ^a	1.76	2.57	-0.26	0.11	0.05	0.10	-0.09	-0.06	-0.14	-0.32	0.75	0.04	(0.70)					
12 Using breaks for independent study (hours) ^a	0.04	0.38	0.07	0.02	-0.01	-0.11	0.01	0.02	0.07	0.14	-0.03	-0.06	-0.09	(0.81)				
13 Planning ^a	3.97	0.71	0.13	-0.27	0.03	-0.02	0.35	-0.26	-0.36	0.16	0.18	0.15	0.21	-0.01	(0.62)			
14 Procrastination ^a	3.00	0.79	-0.06	0.11	0.08	-0.11	-0.24	0.38	0.41	-0.13	-0.04	-0.13	-0.19	0.00	-0.24	(0.61)		
15 Effort ^a	3.86	0.67	-0.05	0.01	-0.11	0.04	0.41	-0.28	-0.35	0.21	0.27	0.20	0.36	0.03	0.40	-0.50	(0.65)	
16 Daily study satisfaction ^a	3.86	0.70	0.30	-0.28	-0.04	0.06	0.36	-0.15	-0.21	0.17	0.07	0.17	0.20	0.03	0.38	-0.62	0.60	(0.79)

Note. For the correlations between the time variables (lecture time, independent study time, and break usage), we omitted the days in which the student had only zero-entries for each of the time variables, otherwise correlations would be biased.

^a Daily assessment.

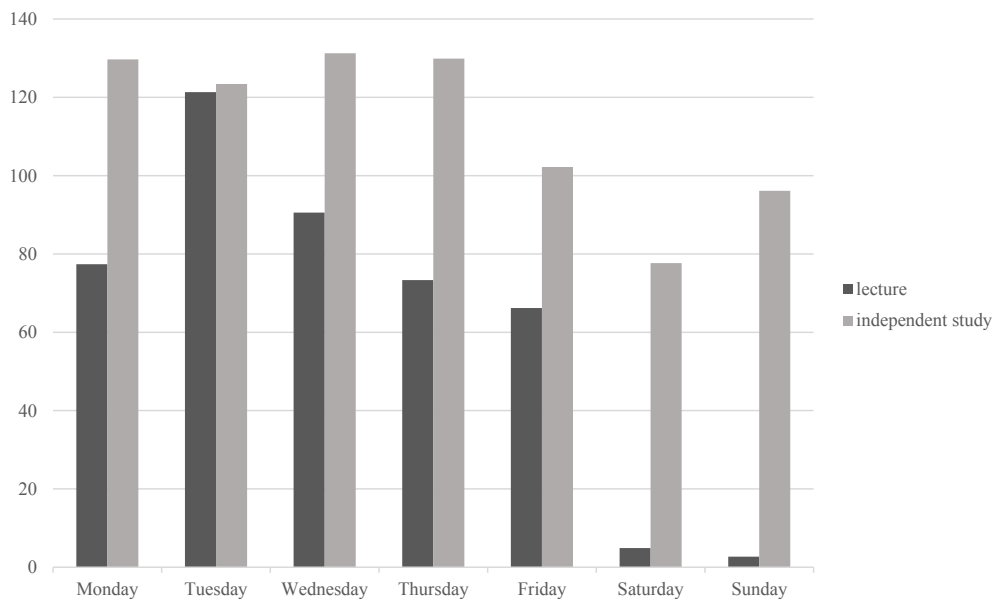


Fig. 1. Students average time investment (in minutes) aggregated over lecture- and independent study time within the lecture period.

Planning. We used three items from the LIST (Lernstrategien im Studium; Wild, 2000) from the time-management subscale (e.g., “I set the hours that I spend on learning, daily by a fixed schedule.”). The Cronbach's alpha was 0.84. For the purpose of validation, we calculated the mean score of the corresponding diary item across all days within each participant. The correlation (r) between the mean score of the diary item and the mean score of the three items in the final evaluation was 0.36.

Procrastination. We used three items from the VCQ (Kuhl & Fuhrmann, 1997) from the procrastination subscale (e.g., “I often postpone unpleasant things”). The Cronbach's alpha was 0.81. The correlation (r) between the mean score of the diary item and the mean score of the survey was 0.41.

Effort. We used three items from the VCQ (Kuhl & Fuhrmann, 1997)

from the effort avoiding subscale (e.g., “I hate to force myself to do things that are difficult”). The Cronbach's alpha was 0.68. The correlation (r) between the mean score of the diary item and the mean score of the survey was -0.35 due to the inverse polarity of the items. Note that this negative correlation is desirable as the daily question regards effort while the scale used for validation measures the opposite concept, i.e., effort avoidance.

3. Results

First, we analyzed participants' time investments by means of aggregated time-series data across the sample for lecture- and independent study. We then analyzed trends over the semester by means of trend analyses and weekly patterns by means of spectral analyses.

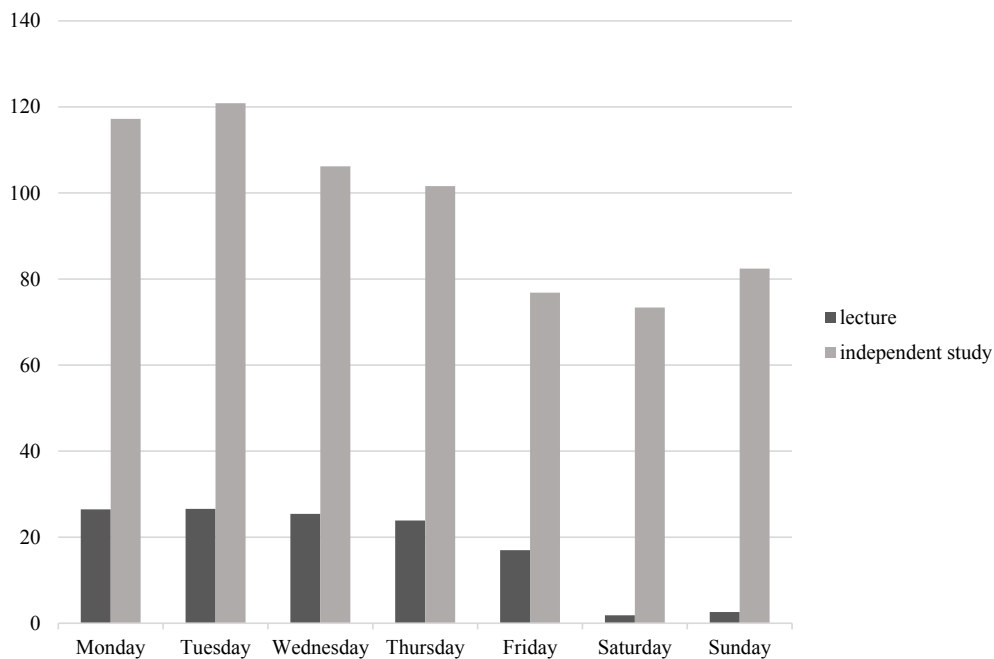


Fig. 2. Students average time investment (in minutes) aggregated over lecture- and independent study time within the non-lecture period.

Finally, we tested the hypotheses about students' daily study satisfaction by means of multi-level modeling.

3.1. Students' time investments throughout the term

In order to analyze the time investments made by students over the course of a term, we aggregated lecture and independent study time investments over participants, days, and lecture vs. non-lecture periods, to analyze semester trends and weekly patterns by conducting time-series analyses for lecture and independent study time investments. Aggregated time investment over weekdays for lecture and independent study time for lecture vs. non-lecture period are displayed in Figs. 1 and

2, respectively. The aggregated trajectories over the whole term for lecture time and independent study time are displayed in Fig. 3, aggregated over days (thin solid line) and weeks (bold dashed line).

3.1.1. Semester trend

Fig. 3 shows the aggregated daily time investment over the 22-week period. The lecture period ends at the end of the 12th week of the survey period. Looking at Fig. 3, one can observe a negative linear trend for lecture time and a quadratic trend for independent study time. The trend analysis shows a significant linear effect for lecture time ($F(1, 152) = 57.97, p < 0.01, \beta = -0.53, R^2 = 0.28$) and a significant linear and quadratic effect for independent study time ($F(2,$

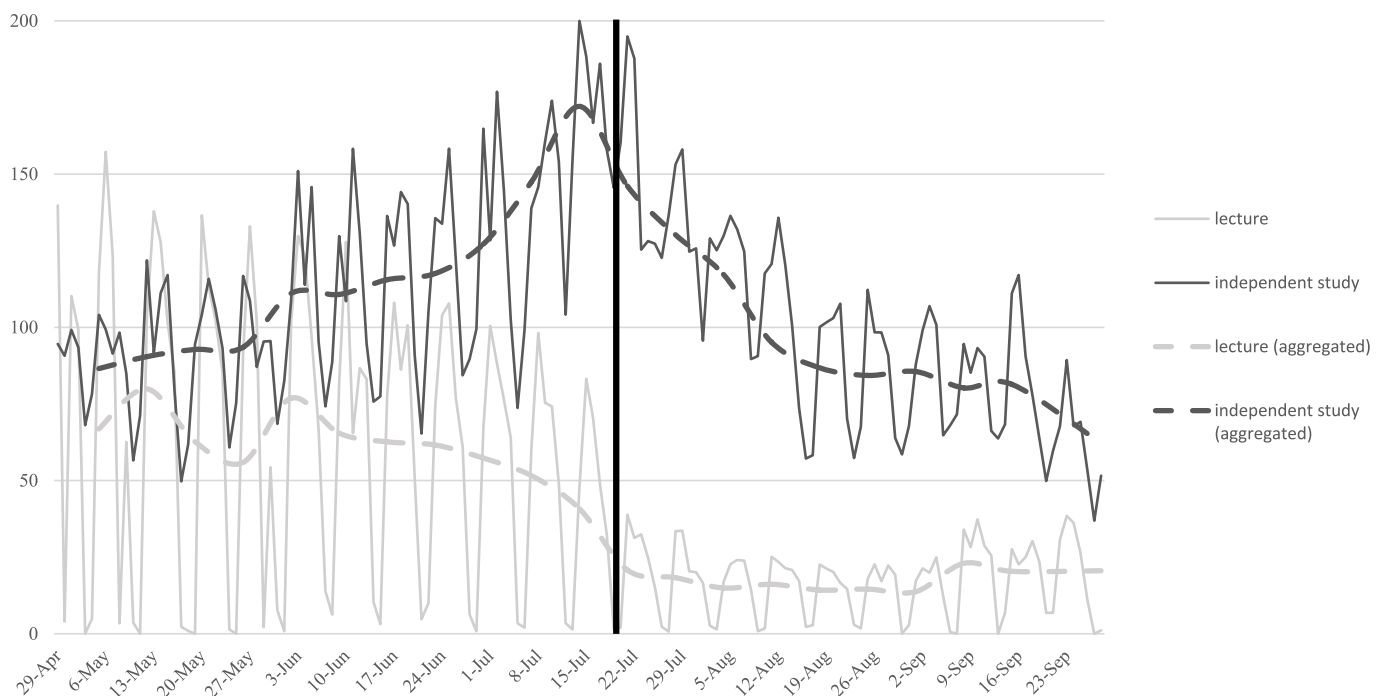


Fig. 3. Students lecture- and independent time investment (solid lines) and average lecture- and independent study time investment (dashed lines) aggregated for weeks 1 to 22 (in minutes). The plumb line indicates the begin of the exam period.

151) = 49.41, $p < 0.01$, $\beta_1 = -0.16$, $\beta_2 = -0.61$, $R^2 = 0.40$). Thus, lecture time investment decreases over time in a linear manner, whereas independent study time shows a quadratic trajectory: it increases up to the end of the lecture period and then decreases until the end of the term.

3.1.2. Weekly pattern

Figs. 1 and 2 show the aggregated daily time investment (Monday to Sunday for the lecture vs. non-lecture period, respectively). The mean time investment in the lecture period was approximately 20.44 h per week and in the non-lecture period approximately 13.37 h per week. Both types of learning show a clear weekly pattern (see Fig. 3). We analyzed the weekly by means of spectral analysis (Jenkins & Watts, 1968; Warner, 1998). Before conducting the spectral analyses, the time-series data of lecture- and independent study time were trend-adjusted. Analysis for both lecture- and independent study time investments shows a periodicity with a frequency of seven, which indicates that a weekly rhythm is observable in both time series. Within the lecture period, students' lecture time has its peak on Tuesdays whereas Wednesdays till Thursdays lecture time slightly decreases and on weekends lecture time approaches zero. Students' independent study time has only some fluctuation between Monday till Thursday, but decreased on since Fridays whereas Saturdays the lowest amount of independent study time is used and increases again on Sundays. Within the non-lecture period, students' lecture time is almost even between Mondays till Fridays and obviously approaching zero on weekends.

3.2. Predicting students' daily study satisfaction

Means, standard deviations, correlations, and reliability values (in parentheses) for the variables of interest are displayed in Table 1. Note that the correlation between the diary variables have been computed by means of the chain-technique (Schmitz & Skinner, 1993; Schmitz & Wiese, 2006). Thus, aggregated scores have only been used with the correlation of trait variables or other variables, which have only been assessed once (i.e., within the initial or final survey).

Following Martin et al. (2015), we examined the amount of variance in each variable due to days, weeks, and subjects (see Table 2). To do so, we calculated intercept only models for each of the daily study variables. As the amount of variance between weeks was very small (0–6%) compared to the amount of variance between days and students, we used a two-level model (i.e., days & persons) to test our hypotheses.

To test our hypotheses concerning students' daily study satisfaction, we performed multilevel analyses (R-package lme4; Bates, Maechler, Bolker, & Walker, 2014) with persons on level 2 and days within persons on level 1, following a step-by-step procedure. Significance was tested at the 5% level. First, we ran an intercept-only model to estimate the partition of variance between and within students. Second, we introduced the four control variables on level 2 (i.e., general studies satisfaction, general studies load, credit point goal for the current term, undergraduate/graduate student) into the model. Third, we added the

two control variables on level 1 into the model (i.e., intended lecture time & independent study time). Subsequently, we began to test the hypotheses sequentially. Therefore, we introduced lecture- and independent study time, using breaks for independent study, planning, procrastination, and effort, in that order. In each case, after introducing one of these predictors, we computed a second (b-) model with the random slope effect of this predictor and tested the same model once more without the random slope, before continuing with the next predictor. We did this to additionally test whether the relation between the respective predictor and students' daily study satisfaction was the same for every student or not. These results are summarized in Table 3.

3.2.1. Share of variance in students' daily study satisfaction related to students

We first ran an intercept-only model to determine the share of between-student variance given by the intra class coefficient (ICC) in students' daily study satisfaction. The results showed that 22% of the variance ($ICC = 0.22$) lay between students, which means that students significantly differed in their daily study satisfaction.

3.2.2. Controlling for general study load, general study satisfaction, and intended number of credit points

First, we introduced the four control variables at the student level (level 2) into the model. Two significantly predicted students' daily study satisfaction ($b_{\text{general satisfaction}} = 0.18$; $b_{\text{general load}} = -0.17$). Thus, the more satisfied students were with their studies in general, the higher their daily study satisfaction. Moreover, the higher the burden students had due to their studies in general, the lower their daily study satisfaction. Students' credit-points goal ($b_{\text{credit-points goal}} = -0.01$), as well as if students were graduates or undergraduates ($b_{\text{graduate}} = 0.12$) did not significantly predict students' daily study satisfaction. During the step-by-step procedure, the estimates of these four variables changed slightly, but their meaning or interpretation remains unchanged.

3.2.3. Controlling for intended amount of lecture and independent study time

Second, we introduced the two control variables at the day level (level 1) into the model. These control variables were entered before the actual lecture and independent study time, because one might argue that daily study satisfaction may not only depend on actual time investment, but rather that it also depends on the time that they intended to invest. Both significantly predicted students' daily study satisfaction ($b_{\text{intended lecture time}} = 0.13$; $b_{\text{intended independent study time}} = 0.12$). During the step-by-step procedure, the estimates of these two variables changed, so that sometimes only students' intended independent study time and sometimes only students' intended lecture time significantly related to students' learning satisfaction (see Table 3).

3.2.4. Lecture time, independent study time, and using breaks for independent study

In the third stage, we began to introduce the time variables. First, we added lecture- and independent study time to test hypothesis 1. Both positively predicted students' daily study satisfaction ($b_{\text{lecture time}} = 0.11$; $b_{\text{independent study time}} = 0.19$). Hence, the more hours students spent at lectures and the more hours they spent at independent study, the higher their satisfaction at the end of the day. The model with the random slope of these two predictors fitted the data significantly better than that without the random slope ($\chi^2(5) = 499.00$, $p < 0.05$). This indicates that the relation between lecture time and students' daily study satisfaction, as well as that between independent study time and students' daily study satisfaction, significantly differs between students. The introduction of lecture- and independent study time into the model reduced the residual variance (intraindividual error variance of students' daily study satisfaction) by 15.3% ($(1.518 - 1.286) / 1.518 = 0.153$).

Table 2
Amount of variance (%) for each study variable in a 3-Level intercept only model.

	Between days (residuals)	Between weeks	Between students
Lecture time	80	6	15
Independent study time	76	3	21
Using breaks for independent study	70	0	30
Planning	75	0	25
Effort	81	1	18
Procrastination	79	1	20
Daily study satisfaction	77	1	23

Table 3
Fixed Effects Estimates (Top) and Variance-Covariance Estimates (Bottom) for Models of the Predictors of students' daily study satisfaction.

Parameter	Model 1	Model 2	Model 3	Model 4a	Model 4b	Model 5a	Model 5b	Model 6a	Model 6b	Model 7a	Model 7b	Model 8a	Model 8b
Fixed effects													
Intercept	3.86 (0.07)	3.89 (0.59)	3.71 (0.58)	3.45 (0.60)	3.87 (0.57)	3.86 (0.57)	3.87 (0.57)	2.91 (0.51)	2.62 (0.50)	4.76 (0.40)	4.64 (0.42)	2.96 (0.40)	2.97 (0.39)
Level 1 (day)													
intended lecture time (hours)			0.13* (0.01)	0.07* (0.01)	0.05* (0.01)	0.05* (0.01)	0.05* (0.01)	0.04* (0.01)	0.04* (0.01)	0.02* (0.01)	0.02* (0.01)	0.00 (0.01)	0.00 (0.01)
intended independent study time (hours)			0.12* (0.01)	0.00 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.03* (0.01)	−0.03* (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.02* (0.01)	−0.02* (0.01)
lecture time (hours)				0.11* (0.01)	0.14* (0.02)	0.13* (0.02)	0.13* (0.02)	0.11* (0.02)	0.11* (0.02)	0.06* (0.01)	0.05* (0.01)	0.03* (0.01)	0.03* (0.01)
independent study time (hours)				0.19* (0.01)	0.23* (0.02)	0.23* (0.02)	0.23* (0.02)	0.21* (0.02)	0.21* (0.02)	0.09* (0.01)	0.08* (0.01)	0.05* (0.01)	0.05* (0.01)
using breaks for independent study (hours)						0.14* (0.05)	0.15* (0.05)	0.15* (0.05)	0.15* (0.05)	0.09* (0.04)	0.11* (0.04)	0.11* (0.04)	0.11* (0.04)
planning								0.22* (0.01)	0.24* (0.02)	0.14* (0.02)	0.13* (0.02)	0.10* (0.02)	0.09* (0.04)
procrastination										−0.53* (0.01)	−0.52* (0.02)	−0.36* (0.02)	−0.34* (0.02)
effort													
Level 2 (students)													
studies satisfaction (in general)		0.18* (0.07)	0.17* (0.07)	0.19* (0.07)	0.14* (0.06)	0.14* (0.06)	0.14* (0.06)	0.12* (0.06)	0.14* (0.06)	0.11* (0.04)	0.12* (0.05)	0.12* (0.04)	0.10* (0.04)
studies load (in general)		−0.17* (0.07)	−0.19* (0.07)	−0.21* (0.07)	−0.24* (0.07)	−0.24* (0.07)	−0.24* (0.07)	−0.20* (0.06)	−0.18* (0.06)	−0.14* (0.05)	−0.13* (0.05)	−0.13* (0.04)	−0.14* (0.04)
credit point goal for the current term		−0.01 (0.01)	−0.02 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.00 (0.01)	−0.00 (0.01)	0.00 (0.01)	0.00 (0.01)
undergraduate (1)/graduate (2)		0.12 (0.14)	0.10 (0.14)	0.06 (0.14)	0.01 (0.13)	0.02 (0.13)	0.03 (0.13)	0.02 (0.12)	0.04 (0.12)	0.03 (0.09)	0.04 (0.10)	0.04 (0.09)	0.02 (0.09)
Random parameters													
Level 2 (student)													
Intercept	0.47	0.40	0.38	0.41	0.53	0.53	0.53	0.45	0.65	0.42	1.02	0.79	1.36
lecture time (slope)					0.02	0.02	0.02	0.01	0.01	< 0.01	0.01	< 0.01	< 0.01
independent study time (slope)					0.02	0.02	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01
using breaks for independent study (slope)							< 0.01	0.01	0.01	< 0.01	0.01	0.01	< 0.01
planning (slope)										0.02	0.02	0.01	0.01
procrastination (slope)											0.04	0.02	0.02
effort (slope)													0.03
Level 1													
Residual	1.62	1.62	1.52	1.39	1.29	1.28	1.28	1.24	1.23	0.90	0.86	0.78	0.76
Deviance	37,378.3	37,360.6	32,112.0	31,281.4	30,782.4	30,773.5	30,772.0	30,421.6	30,364.0	27,277.0	26,927.7	26,006.4	25,800.8

Note. *p < 0.05. Parameters are unstandardized.

Next, we introduced using breaks for independent study into the model to test [hypothesis 2](#). Using breaks for independent study positively predicted students' daily study satisfaction ($b_{\text{using breaks for independent study}} = 0.15$). The more time students spent in independent study during lecture breaks, the more satisfied they were at the end of their study day. We further tested whether the model with the random slope for this predictor better fitted the data. This was not the case ($\chi^2(4) = 1.52, p > 0.05$). Although significant, the introduction of using breaks for independent study into the model reduced the residual variance by only 0.1% ($(1.518-1.284)/1.518-0.153 = 0.001$) compared to the model without this predictor.

3.2.5. Planning, procrastination, and effort

In the fourth stage, we introduced variables that were closely related to time investment. In this stage, we first introduced planning as a predictor for students' daily study satisfaction to test [hypothesis 3](#). Planning positively predicted students' daily study satisfaction above and beyond the previous predictors in the model ($b_{\text{planning}} = 0.22$). The more students planned their study day at the beginning of the day, the more satisfied they were at the end of the day with their study day. We then tested whether the model with the random slope for this predictor better fitted the data and found that it did ($\chi^2(5) = 57.44, p < 0.05$). This means that the relation between planning and students' daily study satisfaction differed significantly between students. The introduction of planning into the model reduced the residual variance by a further 3.7% ($(1.518-1.228)/1.518-0.154 = 0.037$).

Thereafter, we introduced procrastination into the model to test [hypothesis 4](#). Procrastination negatively predicted students' daily study satisfaction above and beyond the previous predictors in the model ($b_{\text{procrastination}} = -0.53$). The less students procrastinated during the day, the more satisfied they were at the end of the day with their study day. It is striking that, at this step, when procrastination was added into the model, the predictive strength of lecture- and independent study time—although still significant—clearly decreased. We again tested for the random slope model, which fitted the data significantly better than the model without this random parameter ($\chi^2(6) = 349.27, p < 0.05$). Hence, the relation between procrastination and students' daily study satisfaction significantly differs between students. The introduction of procrastination into the model reduced the residual variance by a further 24.3% ($(1.518-0.858)/1.518-0.191 = 0.243$).

Finally, we introduced effort into the model to test [hypothesis 5](#). Students' effort positively predicted their daily study satisfaction above and beyond the previous predictors in the model ($b_{\text{effort}} = 0.35$). Students who made an effort during their study day felt more satisfied than students who did not with what they had achieved by the end of the day. Again, the model with the random slope fitted the data significantly better than the model without ($\chi^2(7) = 205.53, p < 0.05$). Introducing effort into the model reduced the residual variance by a further 5.9% ($(1.518-0.761)/1.518-0.435 = 0.059$). Overall, the predictors in the model explained a total of 49.3% of the intraindividual variance in students' daily study satisfaction above and beyond the preliminarily included control variables.

4. Discussion

In our study, 105 students reported their daily learning behavior in a diary for an entire university term (five months), including a 12-week lecture period and 10 weeks of non-lecture period. This study is unique in examining the time investment of university students over such a long period, applying the most suitable data collection method (i.e., daily diary), form of survey (i.e., online), and evaluation method (i.e., descriptive-, trend-, spectral-, and multilevel analyses). The present study investigated the time students spend on their studies, how time investment develops over the course of a whole term, and how students' time investment is related to their daily study satisfaction and how other facets of SRL relate to it in comparison. The main findings are that

average lecture time decreased linearly while independent study time followed a negative quadratic trend. We were also able to predict students' daily study satisfaction through time investment, planning, procrastination, and effort in a hierarchical linear model.

Concerning time investment, we can compare the students examined in this study with those in previous studies in this field. [Schuman, Walsh, Olson, and Etheridge \(1985\)](#) examined students' time investment at the University of Michigan and found that they invested approximately 25 h per week. [Helmke and Tuyet \(1999\)](#) found that students invest 20 h per week with an additional time investment of 6 h for course preparation. This value is similar to that found by [Schulmeister and Metzger \(2011\)](#): an average time investment across the term of 24 h per week. [Meng and Heijke \(2005\)](#) have found that students invest approximately 32 h per week. Note that, in this study, students were asked only retrospectively how many hours a week approximately they spent during term on several tasks. In the study of [Dolton, Marcenaro, and Navarro \(2003\)](#), students were found to spend 4 h a day on lectures and 3.75 h on independent study. [Nonis, Philhours, and Hudson \(2006\)](#) found that students spent approximately 12 h per week on lectures and 16 h per week on independent study. [Babcock and Marks \(2011\)](#) showed that students invested between 25 and 30 h per week. In a 2006 University of California Undergraduate Student Experience Survey, students were found to spend 15.7 h on lecture time and 12.7 h on independent study time ([Brint & Cantwell, 2010](#)). Note that the hours spent in each of the past studies differ clearly. [Schmidt \(1983\)](#) argues that this is because study varies so much among students and different majors that we cannot assume time homogeneity. We argue that the measurement of time is another important aspect regarding why many studies have obtained different results on the aspect of study time. Our result, of approximately 20 h per week within the lecture period, is one of the lowest in terms of students' time investment, but also one of the most strictly evaluated.

Additional results of our study show that university students' learning follows a certain pattern and trend. Lecture time investment decreases in a linear manner as the term progresses. Hence, lecture attendance is relatively regular at the beginning of the term and gradually decreases over time. Towards the end of the lecture period, lecture time investment naturally approaches zero, because only some compact courses are held in the non-lecture period. We see that lecture time decreases over the course of time. [Moore, Armstrong, and Pearson \(2008\)](#) analyzed the reasons why students were absent from lectures. Sixty percent of the students in their study reported that they were absent for low motivation reasons (e.g., disliking the lecture, tired, too long, too boring). In addition, 23% were absent for moderate motivation reasons (e.g., working on other things like preparing a presentation or learning for an exam). These findings may serve as an explanation why students' lecture time decreased in a linear manner over the time span of the lecture period. We found two main reasons to be important. First, students notice, over the course of the term, how useful they find a lecture and may decide individually that some lectures are not useful or even boring. Second, over the course of the term, other obligations increase and exams approach so that they decide to study for the respective exam instead of attending a less useful lecture.

The trajectory of students' independent study time, on the other hand, follows a negative quadratic trend, in that investment in independent study increases over time and reaches its highest point at the end of the lecture period—as many examinations take place at that time—and then decreases over the rest of the term as the number of examinations taking place also decreases (note: the time series is aggregated; at the end of the term, only some participants still have exams that require independent study). These findings are in line with the linear decrease of lecture time. As argued above, students decide to spend more time in independent study than in lectures because approaching exams and the motivation to study specific exam material are evidently more important than attending all lectures. The decrease in independent study time following its climax at the beginning of the

exam period is quite logical, because with each exam that is passed, fewer students have to study for it. Since the trajectory is an aggregated one, it constantly decreases until the end of the term. These trends clearly require researchers who are interested in students' time investment to conduct longitudinal studies of complete terms ideally, as the use of shorter periods poses the risk of distorting the results.

The weekly pattern found for lecture time is due to the fact that lectures are held during the week. Students go slow at the beginning of a week. On Tuesday and Wednesday, they reach the highest point in terms of their time investment. On Friday, students seem to begin preparing themselves for the weekend. On weekends, they use most of their time for other activities. Another reason is the time schedule for lectures, which is a reason for this weekly pattern. Since we also captured the intended lecture time, we could see that it follows the same pattern, which leads to the conclusion that weekdays differ slightly in terms of the lectures offered. In addition, Mondays are the days when many students return from weekend trips (e.g., to their parents' homes) and therefore arrived late to university for some lectures on Mondays. The measurement week did not explain much of the variation in students' lecture- and independent study time (6% and 3%, respectively). This low amount of between-weeks variation is congruent to prior research from Martin et al. (2015), who also found the variance in their study variables (e.g., persistence & disengagement) to not be much due to variation between weeks (4–10%). Different to Martin et al. we found the variance in our study variables to be mostly due to variation between days (70–81%), and only a moderate amount of variation between students (15–30%), whereas Martin et al. found the variance to be mostly due to variation between students (55–81%), and a moderate portion due to within days (9–34%), and only a minimum amount of variation between days (1–6%). Similar to our findings, Tolvanen et al. (2011) found that 12–41% of variation in their study variables (e.g., positive- & negative effect) is between individuals. The high proportion of variation between days compared to other studies maybe since in such a long period (i.e., five month) each student runs through different phases which results in a high variance within each student and thus the proportion of variance between students is much lower.

Although students in the present study possessed, on average, 15 years of learning experience in school and at university combined, this does not necessarily mean that they were able to invest and plan their time effectively. Many students complained about the large investment of time required for their coursework. However, the data indicate that actual time investment across an entire term was not that high. When examining individual trajectories, the large variability in time investment becomes apparent. Thus, university students experience some periods that require large investments of time and presumably attribute those days to their experiences during the entire term. After our study, most students stated that their real time investments were much less than they had previously believed. A reason for this may be that most students attend university in the morning and come home in the evening, yet the time between and after lectures is not necessarily invested in studying.

This study has shown how students can attain a satisfying study day when reflecting on it at the end of the day. Most strikingly, students' time investment (i.e., in lectures and independent study) is not the most important variable. De Jong, Westerhof, and Creemers (2000) have already found that variance in time explained only 2.5% of the variance in achievement. The same seems to be the case with daily study satisfaction. The present results indicate that the amount of independent study time does relate more to students' daily study satisfaction than lecture time. These findings seem interesting since Dolton et al. (2003) showed a four times higher impact of lecture and formal study time than of independent study time on students' academic outcome.

Furthermore, it turns out that using breaks for independent study is an independent predictor above and beyond general time investment. This is an important finding since this is an as-yet unheeded factor. Even more important is the finding that planning early in the day,

procrastination, and effort are all additional independent predictors (see Model 8b in Table 3). This is in accordance with the study by Carroll (1989), who emphasizes that “time as such is not what counts, but what happens during that time” (p. 27). Students' planning at the beginning of their study day turns out to be important for their daily study satisfaction. This result is in line with that of Schmitz and Wiese (2006) who found a correlation of 0.16 between these two variables. Plant et al. (2005) also showed, concerning students' cumulative GPA, that planning (with a correlation of 0.26) is more important than study time itself. Furthermore, time and planning correlate with each other, planning has an impact on students' daily learning satisfaction above and beyond that of time, and planning does more than simply enhance the amount of time students spend in studying. Procrastination has been shown to be the factor most related to students' daily study satisfaction ($r = -0.62$). These results are also in line with those in Schmitz and Wiese (2006), where procrastination has also been shown to be the variable that is most correlated with learning satisfaction (-0.68). Students who procrastinate are significantly less satisfied with their study day under control of time investment, planning, and effort. Flunger et al. (2015) have shown that students' effort is more important than time investment for predicting students' achievements at school and that mere time investment does not provide enough information to describe differences between students. In a similar way, Trautwein (2007) showed that school students homework time did not positively predict students' achievement, whereas students' effort did correlate (0.40) with their achievement. Results comparing the impact of time compared to effort on achievement show similar results as in our study on daily study satisfaction. Effort has also been shown to be highly related with students' daily study satisfaction above and beyond all other variables examined in this study. This implies that effort is practical as distinct from procrastination. To summarize, the individual variance in students' daily study satisfaction has been able to explain up to 50% via online time and three other variables (i.e., planning, procrastination, and effort), which are closely associated with time investment.

Concerning our dependent variable, there is not much potential in prior research to compare our results with. There are several studies on time investment and effort on school students by Flunger, Trautwein and colleagues (e.g., Flunger et al., 2015), but not as much on time investment of university students and no study on daily study satisfaction. Tolvanen et al. (2011) studied the relation of competence and challenge on positive and negative affect within a sample of 72 first-year university students, with both predictor variables and their interaction explaining a total of 24% of variance in affect. Prior research discussed above focused mainly on students' achievement, which is a quite important outcome variable in the academic sector. In that case, the practical implication is paying off at the end of a term or at the point of time where the exam is written or gotten back with a good mark. The peculiarity of the present study lies in the fact that the practical implication pays back daily, for the examined variables predictor students' satisfaction daily and are thus highly qualified to benefit students' study life on a daily basis.

4.1. Practical implications

The results of the present study challenge us to improve learning at university. In line with prior research (Schmitz & Wiese, 2006), the results suggest that SRL strategies, such as time investment, planning, effort regulation, and the avoidance of procrastination, are associated with study satisfaction, which, in turn, is linked to academic achievement. We suggest implications on the institutional level, on the level of university teachers, and on an individual level.

On an institutional level, this implies that there is a need for training interventions for students to foster SRL strategies. Face-to-face trainings have been demonstrated to be effective for increasing the use of such strategies and improving performance (Schmitz & Wiese, 2006).

However, in order to reach large numbers of students, a web-based training approach, as proposed by Bellhäuser, Lösch, Winter, Schmitz (2016), was demonstrated to be more efficient.

Moreover, universities should consider reducing the length of breaks between lectures so that there is less need for students to actively fill these gaps. One way to achieve this might be to increase the use of web-based instruction that allows students to flexibly choose the optimal time of attendance for themselves.

University teachers can support the development of SRL strategies by acting as role models. This can be achieved by explicitly communicating lecture goals and time plan as well as by reflecting whether these goals have been achieved. Further, teachers can remind students to start studying for examinations early.

On an individual level, we highly advise students to plan their study days and to actively consider using breaks for independent study in their learning plan. This strategy seems applicable to all students, as the model with the random slope did not fit the data better than the one without. Furthermore, students should find strategies to prevent procrastination and invest effort into learning time. Carbonaro (2005) also cautions that by de-emphasizing effort, one would overlook an “important potential resource that all students have and can use to improve their academic outcomes” (p. 44).

4.2. Limitations and future directions

This study has several advantages over other studies in the field. However, some potential limitations of this study should be discussed. First, the selection, number, and dropout of participants may be considered disadvantages. The heterogeneity of the student sample results in differing course contents between majors, differing students' workload, and differing structure and course of a term. Nevertheless, the study has high external validity due to its heterogeneous sample. The number of participants might appear to be low; however, one must bear in mind that the participation workload was extraordinarily high (filling in a diary both in the morning and in the evening on at least 123 days). Instead of looking at the bare number of participants, one should rather keep in mind that 16,170 individual data points (105 participants $\times$ 154 days) contributed to our analyses, a value remarkably higher than that in most studies we are aware of. From this perspective, even the dropout rate of 55% seems acceptable. In addition, dropout analysis yielded not significant differences in time investment between dropouts and finishers in the first two survey periods. Nevertheless, it is arguable that instead of capturing a very long time with relatively few students, the study should have chosen a shorter period and therefore gained more participants. However, the aim of the study was to gain a picture over an entire term and to allow students from every major to participate in this study, capturing all the time spent over the entire term. Because every course of study has a different term, this implies that focusing on several specific weeks during a term would have made it impossible to capture students' mean time investment. Thus, a longer survey period was chosen to fulfill this goal, while automatically allowing a decrease in participants. We must therefore acknowledge that a generalization of the 4 h' average time spent during a study day in view of the whole term must be handled with caution.

Another issue was the measurement of daily variables, such as planning, procrastination, and effort, which have all been assessed through self-assessment. The subjective rating of planning, procrastination, and effort may differ between students, as is always the case with self-assessment. On the other hand, assessing these variables objectively for such a sample with such a long survey period is a major challenge, if not impossible.

The daily measurement of self-regulated learning related variables may have also caused a reactivity effect among students during the survey period (Panadero, Klug, & Järvelä, 2015). The reactivity effect explains changes in particular behavior due to metacognitive monitoring (Zimmerman, 2002). Schmitz (2006) considered this effect as an

advantage of diaries. In our study this effect was not intended. Schmitz and Perels (2011) describe that diaries may promote learning due to the increased awareness of important components (i.e., planning, effort, & procrastination), the function as a reminder and reflection tool, and the increasing awareness of the interdependence between these components. However, Likert-type items (as used in our study) are not expected to cause a reactivity effect to the same extent as open questions because participants are less involved in reflection (Schmitz, Klug, & Hertel, 2012). Yet, we cannot completely rule out its existence.

We must acknowledge that we treated students' time investment two-dimensionally (i.e., lecture and independent study time), although many other time investments (e.g., time for family, friends, sleep, hobbies, sports, or job) may also affect daily study satisfaction. For example, studying for 3 h after a working day of 8 h might be more satisfying than studying for 3 h on a day without any other obligations. However, we concentrated on those aspects, which are directly associated with studying.

At least, how and why students differ in their subjective experience of time investment is an issue of importance regarding the gap between perceived and real time investments (also in this study). Therefore, commuting time should be examined in future research as a contributor to students' perceived study time investment.

5. Conclusions

It is very rare to find studies on the time investment of university students, let alone studies with a design that provides insights into the trajectory, rhythm, and amount of time investment while distinguishing between lecture- and independent study time. The present study contributes to the literature in two significant ways. First, it empirically illustrates that students' time investment is not constant, either in lectures or in independent study. Thus, studies in which the time investment of university students is related to other outcome variables of interest must be careful about choosing the most appropriate time span and take this into account when interpreting the relations found. Second, the present study brings students' daily study satisfaction into the equation of educational psychology and shows how this satisfaction is related to students' planning, effort, procrastination, and even use of breaks for independent study, above and beyond the impact of pure time investment. We conclude that time may be the most pressing variable to manipulate, but not the most important one.

References

- Babcock, P., & Marks, M. (2011). The falling time cost of college: Evidence from half a century of time use data. *Review of Economics and Statistics*, 93(2), 468–478.
- Bates, D., Maechler, M., Bolker, B., & Walker, S. (2014). lme4: Linear mixed-effects models using Eigen and S4. *R Package Version*, 1(7).
- Baumert, J., Blum, W., Brunner, M., Dubberke, T., Jordan, A., Klusmann, U., ... Tsai, Y. M. (2009). *Professionswissen von Lehrkräften, kognitiv aktivierender Mathematikunterricht und die Entwicklung von mathematischer Kompetenz (COACTIV): Dokumentation der Erhebungsinstrumente*. Max-Planck-Institut für Bildungsforschung.
- Bellhäuser, H., Lösch, T., Winter, C., & Schmitz, B. (2016). Applying a web-based training to foster self-regulated learning — Effects of an intervention for large numbers of participants. *The Internet and Higher Education*, 31, 87–100. <http://dx.doi.org/10.1016/j.iheduc.2016.07.002>.
- Bennett, S. N. (1978). Recent research on teaching: A dream, a belief and a model. *British Journal of Educational Psychology*, 48(2), 127–147.
- Bloom, B. S. (1976). *Human characteristics and school learning*. McGraw-Hill.
- Brint, S., & Cantwell, A. M. (2010). Undergraduate time use and academic outcomes: Results from the University of California undergraduate experience survey 2006. *Teachers College Record*, 112(9), 2441–2470.
- Carbonaro, W. (2005). Tracking, students' effort, and academic achievement. *Sociology of Education*, 78(1), 27–49.
- Carroll, J. B. (1989). The Carroll model a 25-year retrospective and prospective view. *Educational Researcher*, 18(1), 26–31.
- De Jong, R., Westerhof, K. J., & Creemers, B. P. M. (2000). Homework and student math achievement in junior high schools. *Educational Research and Evaluation*, 6(2), 130–157.
- Dolton, P., Marcenaro, O. D., & Navarro, L. (2003). The effective use of student time: A stochastic frontier production function case study. *Economics of Education Review*, 22(6), 547–560.

- Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologist*, 41, 1040–1048.
- van Eerde, W. (2003). A meta-analytically derived nomological network of procrastination. *Personality and Individual Differences*, 35, 1401–1418.
- European Union (2015). *ECTS users' guide*. Luxembourg: Publications Office of the European Union <http://dx.doi.org/10.2766/87592>.
- Fisher, S. L., & Ford, J. K. (1998). Differential effects of learner effort and goal orientation on two learning outcomes. *Personnel Psychology*, 51(2), 397–420.
- Flunger, B., Trautwein, U., Nagengast, B., Lüdtke, O., Niggli, A., & Schnyder, I. (2015). The Janus-faced nature of time spent on homework: Using latent profile analyses to predict academic achievement over a school year. *Learning and Instruction*, 39, 97–106.
- Fuller, J. A., Stanton, J. M., Fisher, G. G., Spitzmüller, C., Russell, S. S., & Smith, P. C. (2003). A lengthy look at the daily grind: Time series analysis of events, mood, stress, and satisfaction. *Journal of Applied Psychology*, 88, 1019–1033.
- Harnischfeger, A., & Wiley, D. E. (1976). The teaching–learning process in elementary schools: A synoptic view. *Curriculum Inquiry*, 6(1), 5–43.
- Helmke, A., & Tuyet, V. T. A. (1999). Do Asian and Western students learn in different way? An empirical study on motivation, study time, and learning strategies of German and Vietnamese university students. *Asia Pacific Journal of Education*, 19(2), 30–44.
- Howell, A. J., & Watson, D. C. (2007). Procrastination: Associations with achievement goal orientation and learning strategies. *Personality and Individual Differences*, 43(1), 167–178.
- Jagacinski, C. M., & Nicholls, J. G. (1984). Conceptions of ability and related affects in task involvement and ego involvement. *Journal of Educational Psychology*, 76, 909–919.
- Jagacinski, C. M., & Nicholls, J. G. (1987). Competence and affect in task involvement and ego involvement: The impact of social comparison information. *Journal of Educational Psychology*, 79, 107–114.
- Jenkins, G. M., & Watts, D. G. (1968). *Spectral analysis*. Oakland: Holden-Day.
- Keith, T. Z. (1982). Time spent on homework and high school grades: A large-sample path analysis. *Journal of Educational Psychology*, 74(2), 248.
- Keith, T. Z., & Cool, V. A. (1992). Testing models of school learning: Effects of quality of instruction, motivation, academic coursework, and homework on academic achievement. *School Psychology Quarterly*, 7(3), 207.
- Kuhl, J., & Fuhrmann, A. (1997). *VCQ-Volitional components questionnaire*. Universität Osnabrück.
- Lay, C. (1992). Trait procrastination and the perception of person-task characteristics. *Journal of Social Behavior and Personality*, 7, 483–494.
- Lay, C., & Schouwenburg, H. (1993). Trait procrastination, time management, and academic behavior. *Journal of Social Behavior and Personality*, 8, 647–662.
- Martin, T., Flett, G., Hewitt, P., Krames, L., & Szanto, G. (1996). Personality correlates of depression and health symptoms: A test of a self regulation model. *Journal of Research in Personality*, 31, 264–277.
- Martin, A. J., Papworth, B., Ginns, P., Malmberg, L. E., Collie, R. J., & Calvo, R. A. (2015). Real-time motivation and engagement during a month at school: Every moment of every day for every student matters. *Learning and Individual Differences*, 38, 26–35.
- Meng, C., & Heijke, H. (2005). *Student time allocation, the learning environment and the acquisition of competencies*. Maastricht: Research Centre for Education and the Labour Market. Faculty of Economics and Business Administration, Maastricht University.
- Moore, S., Armstrong, C., & Pearson, J. (2008). Lecture absenteeism among students in higher education: A valuable route to understanding student motivation. *Journal of Higher Education Policy and Management*, 30(1), 15–24.
- Nonis, S. A., Philhours, M. J., & Hudson, G. I. (2006). Where does the time go? A diary approach to business and marketing students' time use. *Journal of Marketing Education*, 28(2), 121–134.
- Panadero, E., Klug, J., & Järvelä, S. (2015). Third wave of measurement in the self-regulated learning field: When measurement and intervention come hand in hand. *Scandinavian Journal of Educational Research*, 1–13.
- Pintrich, R. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1993). Reliability and predictive validity of the motivated strategies for learning questionnaire (MSLQ). *Educational and Psychological Measurement*, 53, 801–813.
- Plant, E. A., Ericsson, K. A., Hill, L., & Asberg, K. (2005). Why study time does not predict grade point average across college students: Implications of deliberate practice for academic performance. *Contemporary Educational Psychology*, 30, 96–116.
- Pokay, P., & Blumenfeld, P. C. (1990). Predicting achievement early and late in the term: The role of motivation and use of learning strategies. *Journal of Educational Psychology*, 82, 41–50.
- Richardson, M., Abraham, C., & Bond, R. (2012). Psychological correlates of university students' academic performance: A systematic review and meta-analysis. *Psychological Bulletin*, 138, 353–387. <http://dx.doi.org/10.1037/a0026838>.
- Schmidt, R. M. (1983). Who maximizes what? A study in student time allocation. *The American Economic Review*, 73(2), 23–28.
- Schmitz, B. (2006). Advantages of studying processes in educational research. *Learning and Instruction*, 16(5), 433–449.
- Schmitz, B., Klug, J., & Hertel, S. (2012). Collecting and analyzing longitudinal diary data. In B. Laursen, T. D. Little, & L. A. Card (Eds.). *Handbook of developmental research methods* (pp. 181–195). New York: Guilford Press.
- Schmitz, B., & Perels, F. (2011). Self-monitoring of self-regulation during math homework behaviour using standardized diaries. *Metacognition and Learning*, 6(3), 255–273.
- Schmitz, B., & Skinner, E. (1993). Perceived control, effort, and academic performance: Interindividual, intraindividual, and multivariate time-series analyses. *Journal of Personality and Social Psychology*, 64(6), 1010.
- Schmitz, B., & Wiese, B. S. (1999). Eine Prozessstudie selbstregulierten Lernverhaltens im Kontext aktueller affektiver und motivationaler Faktoren. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie*, 31(4), 157–170.
- Schmitz, B., & Wiese, B. S. (2006). New perspectives for the evaluation of training sessions in self-regulated learning: Time-series analyses of diary data. *Contemporary Educational Psychology*, 31(1), 64–96.
- Schouwenburg, H. C. (2004). Procrastination in academic settings: General introduction. In H. C. Schouwenburg, C. H. Lay, T. A. Pychyl, & J. R. Ferrari (Eds.). *Counseling the procrastinator in academic settings* (pp. 3–17). Washington: American Psychological Association.
- Schulmeister, R., & Metzger, C. (2011). *Die Workload im Bachelor: Zeitbudget und Studierverhalten: Eine empirische Studie*. Münster: Waxmann.
- Schuman, H., Walsh, E., Olson, C., & Etheridge, B. (1985). Effort and reward: The assumption that college grades are affected by quantity of study. *Social Forces*, 63(4), 945–966.
- Senecal, C., Koestner, R., & Vallerand, R. (1995). Self-regulation and academic procrastination. *The Journal of Social Psychology*, 135, 607–619.
- Solomon, L. J., & Rothblum, E. D. (1984). Academic procrastination: Frequency and cognitive-behavioural correlates. *Journal of Counseling Psychology*, 31, 504–510.
- Steinberg, E. (1989). Cognition and learner control: A literature review, 1977–1988. *Journal of Computer-based Instruction*, 16, 117–121.
- Tolvanen, A., Kiuru, N., Leskinen, E., Hakkarainen, K., Inkinen, M., Lonka, K., et al. (2011). A new approach for estimating a nonlinear growth component in multilevel modeling. *International Journal of Behavioral Development*, 35(4), 370–379.
- Trautwein, U. (2007). The homework–achievement relation reconsidered: Differentiating homework time, homework frequency, and homework effort. *Learning and Instruction*, 17(3), 372–388.
- Trautwein, U., & Lüdtke, O. (2007). Students' self-reported effort and time on homework in six school subjects: Between-students differences and within-student variation. *Journal of Educational Psychology*, 99(2), 432.
- Veenman, M. V., Van Hout-Wolters, B. H., & Afflerbach, P. (2006). Metacognition and learning: Conceptual and methodological considerations. *Metacognition and Learning*, 1(1), 3–14.
- Warner, R. M. (1998). *Spectral analysis of time-series data*. New York: Guilford.
- Watson, D. (1988). Intraindividual and interindividual analyses of positive and negative affect: Their relation to health complaints, perceived stress, and daily activities. *Journal of Personality and Social Psychology*, 54(6), 1020–1030.
- Wentzel, K. R. (1989). Adolescent classroom goals, standards for performance, and academic achievement: An interactionist perspective. *Journal of Educational Psychology*, 81, 131–142.
- Wild, K.-P. (2000). *Lernstrategien im Studium*. Münster: Waxman.
- Wolters, C. A. (2003). Understanding procrastination from a self-regulated learning perspective. *Journal of Educational Psychology*, 95(1), 179.
- Zimmerman, B. J. (2000). Attaining self-regulation. A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.). *Handbook of self-regulation* (pp. 13–39). London, UK: Academic Press.
- Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory Into Practice*, 41(2), 64–70.