



# The effect of perceptions of the teaching-learning environment on the variation in approaches to learning – Between-student differences and within-student variation



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## ABSTRACT

The study explored the extent to which university students' approaches to learning (SAL) are related to their perceptions of the teaching-learning environment (TLE), both at the group level (between-student variation) and at the individual level (within-student variation). Moreover, the study explored how a general tendency to perceive the TLE in a certain way predicts course-specific approaches to learning over and above the course-specific perceptions. The participants were 147 natural sciences undergraduate students. SAL and perceptions of the TLE were measured after five courses using the Learn questionnaire. Hierarchical linear modeling (HLM) was used as the analysis method, which enabled us to test whether the relationships of the TLE and SAL variables were similar at the group and individual levels. For the most part, the relationships were similar but stronger at the group level; further, some of the within-student variation in SAL could be predicted by the group-level perceptions of the TLE.

## 1. Introduction

### 1.1. Variability in students' approaches to learning

Recent years have seen a growing interest in exploring the variability in students' approaches to learning. Some studies suggest that these approaches are prone to change due to various contextual effects or individual development (e.g. Baeten, Kyndt, Struyven, & Dochy, 2010; Coertjens, Vanthournout, Lindblom-Ylänne, & Postareff, 2016; Nieminen, Lindblom-Ylänne, & Lonka, 2004; Vermunt, 2005), while others suggest that the approaches remain relatively stable across time and different contexts (e.g. Lietz & Matthews, 2010; Zeegers, 2001). Approaches to learning refers to students' intentions concerning their studying and learning as well as their learning processes (e.g. Biggs, 2001; Entwistle, 1988; Entwistle, McCune, & Scheja, 2006; Entwistle & Ramsden, 1983; Marton & Säljö, 1976). A *deep approach* refers to the intention of students' to analyse and understand information through relating ideas and using evidence. A *surface approach* is characterised by an intention to memorise and reproduce the content of the study material. Students adopting the latter approach primarily apply rote-learning strategies such as memorising, and see information as

unrelated bits and pieces. The third approach, *organised studying*, refers to students' everyday study practices in terms of how they organise their studies and manage their time. It is therefore considered to be more of an approach to studying than an approach to learning (Entwistle, 2009; Entwistle & McCune, 2004).

The effect of contextual factors on approaches to learning has been investigated mainly through examining the effect of different kinds of teaching-learning environments (TLEs) on the three approaches or by focusing on the relation between students' perceptions of the TLE and their approaches to learning. Studies concerning the effect of the TLE to learning have found contradictory results on how a student-centred learning environment enhances the adoption of a deep approach. Trigwell, Prosser, and Waterhouse (1999) suggest that when a teacher adopts a more student-focused approach to teaching, the students are more likely to adopt a deep approach to learning. Conversely, in TLEs where a teacher adopts a teacher-focused approach to teaching, the students are more likely to adopt a surface approach to learning. On the other hand, there is evidence that student-centred TLEs do not necessarily support the adoption of a deep approach, but instead may even increase the use of a surface approach (e.g. Baeten et al., 2010; Gijbels, Segers, & Struyf, 2008; Segers, Nijhuis, & Gijbels, 2006;

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Struyven, Dochy, Janssens, & Gielen, 2006).

Most studies that have investigated students' approaches to learning in a certain context have been conducted at the between-student level leaving within-student variation unexplored and focusing on the students' general tendencies. Recently, however, there has been a growing interest in examining how approaches to learning vary within individuals across contexts. For example, previous research focusing on both the general tendency to adopt a certain approach and course-specific approaches to learning found a significant and positive relationship between these two levels (Coertjens et al., 2016; Gijbels, Coertjens, Vanthournout, Struyf, & Van Petegem, 2009). However, Gijbels et al. (2009) also found individual differences in that some students showed remarkable changes in their approaches when comparing their commonly adopted and course-specific approaches, while other students' approaches remained more stable. Wilson and Fowler (2005) showed that students who considered their approach to learning to be typically deep maintained their approach across different contexts while students who reported that they typically adopt the surface approach were more likely to adopt deeper processing strategies in a more student-focused environment. Other studies have also shown that certain students show a *disposition to understand for themselves* (McCune & Entwistle, 2011; Postareff, Lindblom-Ylänne, & Parpala, 2014), which means that these students display a strong deep approach throughout different contexts. On the other hand, students who display more variation in their approaches have been shown to be more vulnerable to the effects of the learning environment, such as quality of teaching or course demands (Postareff et al., 2014).

Studies focusing on the relation between the students' perceptions of the TLE and their approaches to learning have shown that students may perceive the same environment differently (Entwistle, Meyer, & Tait, 1991; Parpala, Lindblom-Ylänne, Komulainen, Litmanen, & Hirsto, 2010). Positive perceptions of the TLE are related to a deep approach to learning while more negative perceptions are associated with a surface approach (Kreber, 2003; Lawless & Richardson, 2002; Parpala et al., 2010; Sadlo & Richardson, 2003).

Furthermore, positive perceptions of teaching are associated with higher quality learning outcomes (Prosser & Trigwell, 1991). If students 1) perceive that teaching supports their understanding, 2) the staff is enthusiastic and supportive, 3) courses are interesting and relevant, 4) they are provided with constructive feedback, 5) they receive support from other students and 6) teaching is constructively aligned, they are more likely to study in an organised manner and adopt the deep approach to learning (Entwistle, McCune, & Hounsell, 2003; Parpala et al., 2010; Rytönen, Parpala, Lindblom-Ylänne, Virtanen, & Postareff, 2012). The sixth element, constructive alignment of teaching, refers to an outcomes-based approach to teaching in which the intended learning outcomes are clearly defined before teaching takes place. Teaching activities are designed to support the achievement of the deeper learning outcomes and assessment tasks focus on the attainment of those intended learning outcomes. Therefore, the learning outcomes, teaching and assessment should all be aligned (Biggs & Tang, 2011).

The afore-mentioned six dimensions of the TLE represent the high quality higher education supporting students' deep approach to learning (Entwistle et al., 2003) and there is a strong latent factor of good teaching or academic quality summing all these dimensions (Entwistle, 2009; Richardson, 2005). When exploring the relation between these six dimensions of the TLE and students' approaches to learning, Coertjens et al. (2016) found that two perceptions on the TLE significantly predicted the adoption of specific approaches. First, a significant positive association was found between perceived interest and relevance and organised studying. Second, perceptions of receiving peer support were positively associated with the deep approach to learning and organised studying.

As mentioned above, research on approaches to learning has mostly focused on variation between students while within-student variation has rarely been analysed. It is known that between-students analyses do

not capture variation at the within-student level: "Between-subjects models do not imply, test, or support causal accounts that are valid at the individual level" (Borsboom, Mellenbergh, & van Heerden, 2003, p. 214). Therefore, research combining these two perspectives is needed.

### 1.2. Hierarchical linear modeling in exploring variability versus stability in approaches to learning

To examine the much debated question of the variability versus stability of approaches to learning, we suggest the use of *Hierarchical Linear Modeling (HLM)* as it allows teasing apart between- and within-student sources of variation in approaches to learning and perceptions of the learning environment. HLM analysis of between-student variation gives us information about the extent to which approaches to learning are affected by stable individual factors, while within-student analyses illuminate the ways that the approach to learning adopted by a given student differs from one occasion to another. By "stable individual factors" we refer to, for instance, the enduring interest that the students feel toward their university studies across a long period of time.

The need to simultaneously account for between-student variation and within-student variation is underscored by recent results according to which positive and negative within-students changes in approaches to learning may cancel each other out and result in apparent zero change at the group level (Lindblom-Ylänne, Parpala, & Postareff, 2013; Postareff, Parpala, & Lindblom-Ylänne, 2015). Further, variability in approaches to learning has mostly been explored using two measurement points (e.g. Asikainen, Parpala, Lindblom-Ylänne, Vanthournout, & Coertjens, 2014; Vanthournout, Coertjens, Gijbels, Donche, & Van Petegem, 2013), or at most four points (Vanthournout, 2011). HLM can utilise information from multiple measurement occasions and account for both individual and group level effects. This is important, as it is possible that two variables correlate positively in a group of individuals, but negatively within all individuals across time. For instance, and to borrow and illustrative example from another domain, it is known that a high childhood IQ is associated with higher alcohol consumption later in life, whereas it is unlikely that the IQ of any individual will increase with increasing alcohol consumption (Kievit, Frankenhuis, Waldorp, & Borsboom, 2013). A situation in which a relationship observed at the group level disappears or reverses within subgroups, or within individuals across time, is known as Simpson's paradox (Kievit et al., 2013). In this study, we examine the relationship of perceptions of the TLE and approaches to learning both at the between-students level and within individual students across courses to assess whether these two relationships are similar in nature. It is conceivable, for instance, for a high level of support from other students to be associated with a low level of surface approach to studying on a group level, but when individual students receive more and more support from other students, they may end up adopting a surface approach to studying, at least if the support in question materialises as concrete help with assignments. Answering the question is important for assessing the extent to which the results of previous studies, carried out mostly at the aggregate level, apply to individual students. The results thus provide important new insights on the variability of approaches, which has been widely discussed and debated among researchers due to the diverse previous findings.

Moreover, by using HLM as an analysis method, we may be able to shed light on seemingly paradoxical previous findings where analyses based on the same variables on the within-student level and the between-student level provided seemingly contradictory results. Asikainen et al. (2014) analysed changes in students' approaches to learning and perceptions of the TLE from the first to the third study year, and the way that these changes were related to each other. They found that an increase in students' perceptions that teaching supported their understanding was associated with an increase in students' deep approach. However, the study also showed that at the between-student

level, students' perceptions of the quality of the TLE decreased and their deep approach increased from the first to the third study year (see Asikainen et al., 2014).

Finally, studies with multiple measurement points focusing on the variation in students' approaches to learning are scarce, because of challenges in collecting data from the same students several times in an academic context where students usually have a freedom to design their own study paths. The design of the present study with five measurement points enables us to analyse within-student variation using HLM, while calculating averages over the courses allows the between-student analysis. The average scores are interpreted as reflecting the students' general tendencies in their approaches to learning and their perceptions of the TLE. Moreover, the study tackles the unexplored topic of how this general tendency to perceive the TLE in a certain way predicts course-specific approaches to learning over and above the course-specific perceptions. From a practical perspective, this kind of approach provides information on which aspects of the TLE are central in attempts to support desirable approaches to learning, both in general and in the context of individual courses.

### 1.3. The aim of the study

Previous studies have examined the relations between students' approaches to learning and their perceptions of the TLE either on individual courses (e.g. Coertjens et al., 2016; Gijbels et al., 2008) or across courses, e.g. focusing on study programs (e.g. Parpala, Lindblom-Ylänne, Komulainen, & Entwistle, 2013). In our view, both points of view are reasonable. Thus, the aim of this study is to examine the relations between course-specific approaches to learning and course-specific perceptions of the TLE as indicating academic quality, and between approaches across courses (later referred to as 'general approaches') and perceptions of the academic quality across courses (later referred to as 'general perceptions of the TLE'). Next to this, the study combines the course-specific and general perspectives by investigating to what extent students' general perceptions of their TLE are related to their course-specific approaches.

Two main research questions, the latter with three sub-questions, were formulated in order to investigate the variability from both the between- and within-student perspectives. Because of the contradictory findings concerning the variability of approaches to learning and lack of research combining the course-specific and general perspectives, previous literature is incapable of providing reasonable hypotheses. Thus, the current research is exploratory in nature.

**RQ1:** How stable versus fluctuating are the students' approaches to learning and their perceptions of the teaching-learning environment (TLE)?

**RQ2:** Can approaches to learning be explained by perceptions of the TLE both when considering differences between students and the way individual students differ from the way they behave usually?

**RQ2a:** How is one's general tendency to perceive the TLE in a certain way related to one's general tendency to adopt a certain approach (between-student variation)?

**RQ2b:** How is one's course-specific perception of the TLE related to one's course specific approach to learning (within-student variation)?

**RQ2c:** How is one's general tendency to perceive the TLE in a certain way related to one's course-specific approaches to learning, over and above one's course-specific perceptions of the TLE (both within-student and between-student variation)?

The question of stability vs. variability of approaches to learning and perceptions of the TLE (RQ1) is operationalised as the ratio of within-student and between-student variation to total variation of the approaches and perceptions. The phenomena can be considered stable if a large proportion of total variability occurs at the between-student level and fluctuating if it occurs at the within-student level. When answering research questions 2a-2c, we regress each of the dependent

variables (approaches to learning) on a single independent variable (perceptions of the TLE) at a time. This is done because one of our central aims is to assess whether the between-student and within-student effects are similar in nature and whether the effects are of roughly equal magnitude on both levels. This allows for a straightforward test of whether the Simpson's paradox (e.g. Kievit et al., 2013) applies to the present data: ruling out that possibility is an important prerequisite for interpreting the findings of cross-sectional studies as applying to individual students (even though it is naturally possible that other reasons, such as cohort effects, remain for not being able to do so). Further, in RQ2c, we investigate the ways in which the students' general tendency to view the TLE in a certain way affect their course-specific approaches to learning *after* taking into account their course-specific approaches to learning; being able to take this latter point of view is a unique benefit of the longitudinal design of the present study. This allows assessing which elements in the TLE are generally the most relevant factors related to course-specific approaches to learning.

## 2. Materials and methods

### 2.1. Participants and design

The participants were 147 undergraduate natural sciences students. The data were collected upon the completion of five courses held within 18 months during the first and second study years. The participants began their studies in autumn 2010 and the first data set was collected in spring 2011 (Table 1). The courses were taken in the same order by the students, according to how studies are organised at the University of Helsinki. The mean age of the students was 23.2 years (SD 5.0 years), with a minimum value of 18 and a maximum of 49. The participants comprised 118 (80.3%) females and 29 (19.7%) males. The respective values for the five courses are reported in Table 1. The numbers of students in Table 1 refer to those who actually participated on the courses instead of those originally enrolled on them.

The courses were targeted for first and second year students, and were large and mandatory in nature.

Teaching consisted mainly of lecturing and can be characterised as teacher-focused. All courses included a written final exam.

The students participating on the courses were asked to complete a questionnaire, delivered on paper, at the end of each course during the last class or final exam. The students were instructed to think of their studying and learning during that course when filling in the questionnaires.

The students participated in the study on a voluntary basis and gave their informed consent to participate. They were told that they could withdraw from the study at any time. Anonymity of the participants was ensured in the research process. According to the Guidelines of the Finnish Advisory Board on Research Integrity (2009), this study did not require Finnish ethics review or human subject approval, as it did not involve deviation from informed consent, intervention in the physical integrity of the participants, children under the age of 15, exposure to exceptionally strong stimuli or causing long-term mental harm or risking participants' security.

**Table 1**  
Characteristics of the participants and measurements.

	Course				
	1	2	3	4	5
N	84	122	104	130	105
Age	22.6	22.6	23.0	22.8	22.7
Gender (% female)	81,0	81,2	86,5	80,0	83,8
Data collection date	03/2011	01/2012	03/2012	03/2012	10/2012

## 2.2. Measures

The students completed the HowULearn Questionnaire (Parpala & Lindblom-Ylänne, 2012), which measures students' approaches to learning and their perceptions of their TLE, more precisely their perception of academic quality (Entwistle, 2009). The questionnaire originates from two inventories: the Approaches to Learning and Studying Inventory (ALSI; Entwistle & McCune, 2004) and Experiences of Teaching and Learning Questionnaire (ETLQ; Entwistle et al., 2003). The HowULearn Questionnaire has been developed over many years based on extensive statistical analysis as well as student and expert interviews held at the University of Helsinki. Twelve items measure students' approaches to learning (deep approach, surface approach and organised studying), and twenty-two items the students' perceptions of their TLE (perceived interest and relevance, teaching for understanding, alignment, staff enthusiasm and support, constructive feedback and support from other students). Items are scored on a five-point Likert scale (“Totally disagree” to “Totally agree”). The instrument has been found to be robust across contexts (Parpala et al., 2013; Parpala & Lindblom-Ylänne, 2012). In the present study, the reliabilities for the deep and surface approach scales were generally above 0.70 on the five courses and above 0.80 for the organised studying scale (See Supplementary Table 1 for details). Further, zero-order correlations among the TLE variables and approaches to learning variables at the between-students level are reported in Supplementary Table 2. Finally, the means of the TLE variables are reported in Supplementary Table 3.

## 2.3. Nature and amount of missing data

The design was unbalanced in that not all 147 students responded on all of the courses (Table 1), because all students were not present when the questionnaires were delivered. In addition, a small proportion of the students may not have taken all the courses even though that is the recommended path. The pattern of missing data was non-monotone, i.e., students who missed e.g. course 3 may have taken part in courses 4 and 5. In addition, data were missing on the independent variables (TLE variables) on occasions where data were present for the dependent variable (approach to learning). However, the percentage such observations was small: < 5% of all observations in all of the independent variables.

A two-step approach of accounting for the missing values was applied. First, single imputation of the missing covariates was performed using the Expectation Maximization (EM) method in SAS. The students' id variable was used among the predictors of missingness to account for the multilevel nature of the data: when only a small amount of data is missing (such as < 4%), single imputation methods may be feasible (Schafer & Graham, 2002). Second, the analysis itself was performed using maximum likelihood (ML) estimation.

## 2.4. Statistical analyses

The structure of the data was hierarchical in nature, with each of the 147 students attending multiple courses. Accordingly, we constructed a hierarchical model with 147 observations at level 2 (students) and 545 observations at level 1 (courses). All statistical analyses were performed within the hierarchical linear modeling (HLM) framework using SAS Enterprise Guide 5.1. software. In all models, each approach to learning acted as the dependent variable and, except for the empty model, perceptions of the TLE as fixed independent variables. On level 1, the TLE scores concerned the course in question and on level 2, students' means across all courses they attended. The conceptual idea of our models was to treat within-student variation (level 1 variation) in approaches to learning as fluctuation around a student's personal mean, and between-student variation (level 2 variation) as differences from the overall mean of the whole sample. Accordingly, level 1 independent variables were centered on the students' own mean scores and those at

level 2 on the grand mean score of the whole sample. Our approach to data analysis is derived from the models described in detail in Hoffman and Stawski (2009). These authors propose that the individual person can be viewed as the context for within-person deviations from how the person typically behaves. The idea is conceptually analogous to models in which students are nested within schools, and the schools function as the context for effects concerning the students, and to models in which a family functions as the context for effects concerning individual family members (e.g. Feaster, Brincks, Robbins, & Szapocznik, 2011).

We considered the statistical power of our analyses sufficient to detect effects of various sizes. First, in a two-level model, sample sizes on level 2 play a larger role than those on level one. A simulation study has shown that level 2 sample sizes that exceed 50 result in general in correct standard error estimates, while parameter estimates themselves were unbiased irrespective of sample size (Maas & Hox, 2005). In addition, Scherbaum and Ferrerter (2009) investigated the effects of level one and level two sample sizes and effect sizes on statistical power. A combination of medium effect size (ES = 0.5),  $\alpha = 0.05$ , level two sample size of 40, and level one sample size of five resulted in a power of roughly 0.76. Our sample size of 147 students was, then, clearly large enough to detect effects of medium size. On the other hand, when the effect size was small (0.20), power remained at roughly 0.19 for this combination of sample sizes (Fig. 3, *ibid.*). Our level two sample size was, however, much larger, and extrapolating from Fig. 3 (*ibid.*), level two sample size of 150 and level one sample size of five was associated with a power of roughly 0.6 to 0.7 to detect small effects. The present study, then, had a good power to detect effects of medium to high size and decent power to detect effects of small size.

### 2.4.1. Hierarchical linear model equations and estimation

First, empty models with no predictors (Eqs. (1) and (2)) were fit to estimate the values of the intraclass correlation (ICC, Eq. (3)). Calculating the ICCs for all dependent variables answers our research question 1 of how much variation there is within students (from one course to another) and between students. We also calculated ICCs for the independent variables to assess whether they could be used as predicting variation on both levels of the model. In what follows, the equations are presented for the Deep approach to learning; comparable models were fitted for the other dependent variables. Similarly, perceived interest and relevance is used as an example of the independent variables in the equations that follow. In the equations, we refer to perceived interest and relevance as “interest”.

$$Deep_{cs} = \beta_{0s} + e_{cs} \quad (1)$$

$$\beta_{0s} = \gamma_{00} + U_{0s} \quad (2)$$

In Eqs. (1) and (2),  $Deep_{cs}$  refers to the Deep approach of student S on course C,  $\beta_{0s}$  to the average Deep approach of student S,  $e_{cs}$  to within-student residual variance,  $\gamma_{00}$  to the average Deep approach in the whole sample (i.e. sample grand mean) and  $U_{0s}$  to the amount by which the Deep approach of student S deviates from the average Deep approach in the whole sample. ICC can be defined using the random error variation components as specified in Eq. (3):

$$\begin{aligned} ICC &= \frac{\text{Variation between students}}{\text{Variation between students} + \text{variation within students}} \\ &= \frac{\text{Var}(U_0)}{\text{Var}(U_0) + \text{Var}(e)} \end{aligned} \quad (3)$$

To further illustrate our modeling approach, the level 1 regression equation for predicting the Deep approach by perceived Interest and relevance, together with a set of categorical variables describing the course attended, is given in Eq. (4). The categorical variables are included to account for possible differences among the approaches to learning taken during the five courses. The so-called simple coding system was used with the categorical indicator variables. In simple coding, each level of the course variable is compared to the grand mean

of all the levels of the variable, which is helpful when interpreting the intercept term in the regression equations. In other words, the indicator related to the course of interest received a code of 4/5 and the other indicators a code of  $-1/5$ . This coding scheme is used for instance by Nuthmann and Malcolm (2016).

In Eq. (4),  $Deep_{cs}$  refers to the Deep approach of student S attending course C,  $\beta_{0S}$  to the average Deep approach of student S,  $\beta_{1S}$  to the regression coefficient for perceived Interest and relevance for student S,  $interest_{PM}$  to the personal mean of interest for student S, and  $e_{cs}$  to the within-student residual term. As interest is centered on the student's personal mean, this equation describes purely within-person variation.  $C_1 \dots C_4$  are the categorical indicator variables for the courses, and  $\beta_{2S} \dots \beta_{5S}$  the associated regression coefficients.

Level 1 equation (within-student level):

$$Deep_{cs} = \beta_{0S} + \beta_{1S} \times (interest_{CS} - interest_{PM}) + \beta_{2S} \times C_1 + \beta_{3S} \times C_2 + \beta_{4S} \times C_3 + \beta_{5S} \times C_4 + e_{cs} \quad (4)$$

In addition to examining within-student variation, we investigated variation between students. For this purpose, we predicted the student's mean Deep approach across courses by the mean of interest across courses. Eqs. (5) and (6) describe the level 2 regression equations:

Level 2 equation (between-student level):

$$\beta_{0S} = \gamma_{00} + \gamma_{01} \times (interest_{PM} - interest_{GM}) + U_{0S} \quad (5)$$

In Eq. (5),  $\beta_{0S}$  refers to the average Deep approach for student S,  $\gamma_{00}$  to the overall average Deep approach in the whole sample (i.e. sample grand mean),  $\gamma_{01}$  is the regression coefficient for predicting the students' average Deep approach,  $interest_{GM}$  is the grand mean of perceived Interest and relevance in the whole sample, and  $U_{0S}$  refers to random error between students. This parameterisation (person-mean centering of level-1 predictors, grand-mean centering of level-2 predictors) has two desirable properties. First, predictors on both levels contain variation related to that level only, and second, a meaningful interpretation can be given to positive and negative regression coefficients on both levels. That is, a positive (negative) coefficient on level 1 refers to more (less) of the predictor than what is usual for the student, and on level 2 to more (less) of the predictor than what is typical for the other students in the sample.

$$\beta_{1S} = \gamma_{10} \quad (6)$$

$$\beta_{2S} = \gamma_{20} \quad (7)$$

$$\beta_{3S} = \gamma_{30} \quad (8)$$

$$\beta_{4S} = \gamma_{40} \quad (9)$$

$$\beta_{5S} = \gamma_{50} \quad (10)$$

Eq. (6) shows that we assume no between-student variation in the regression slopes, and Eqs. (7)–(10) represent the fact that we assume no level 2 moderation effects in the relationships depicted.

Substituting the relevant terms from Eqs. (5)–(10) into Eq. (4) and arranging the terms gives the single Eq. (11) that describes our approach to modeling the data:

$$Deep_{cs} = \gamma_{00} + \gamma_{01} \times (interest_{PM} - interest_{GM}) + \gamma_{10} \times (interest_{CS} - interest_{PM}) + \gamma_{20} \times C_1 + \gamma_{30} \times C_2 + \gamma_{40} \times C_3 + \gamma_{50} \times C_4 + U_{0S} + e_{cs} \quad (11)$$

All analyses were based on maximum likelihood (ML) estimation. Approximations of the number of degrees of freedom were obtained using the Kenward-Rogers method (Schaalje, McBride, & Fellingham, 2001). The significance of the independent variables was evaluated by Wald tests and likelihood ratio tests. In large samples the two tests produce asymptotically equivalent results, but performing the likelihood ratio tests is advantageous in smaller samples or when testing

the significance of several independent variables (Hox, 2010, p. 49). The likelihood ratio tests are based on comparing the model of interest to a baseline model. The baseline model is depicted in Eq. (12), in which  $\beta_{0S}$  refers to the average Deep approach of student S,  $C_1 \dots C_4$  represent the categorical indicator variables for the courses and  $B_2 \dots B_5$  the associated regression coefficients.

$$Deep_{cs} = \beta_{0S} + \beta_{2S} \times C_1 + \beta_{3S} \times C_2 + \beta_{4S} \times C_3 + \beta_{5S} \times C_4 + e_{cs} \quad (12)$$

The comparisons between the models of interest and the baseline model were carried out by likelihood ratio tests based on maximum likelihood estimation (rather than restricted maximum likelihood estimation) because the models differed in their fixed effects structures. When calculating reduction in unexplained variance, the procedure outlined in Snijders and Bosker (2011, chapter 7) was followed. As the number of level 1 measurements within the level 2 units possibly differed, a representative number of measurements was used in calculating the level 2 reduction in unexplained variance. We used the number of courses, five, in these calculations.

#### 2.4.2. Analyses related to each research question

Research question 1 (addressing the stability versus fluctuation of approaches and perceptions of the TLE) was answered by estimating the coefficients of Eqs. (1)–(3), and research question 2a (investigating how one's general perceptions of the TLE are related to one's general approaches) by those of Eq. (5). Research question 2b (investigating how one's course specific perceptions of the TLE are related to one's course specific approaches) was answered by estimating the coefficients of Eq. (4). Eq. (4) describes the idea that for student S, the mean of perceived interest and relevance across the five courses is  $interest_{PM}$ , but that student S may perceive the individual courses as more interesting and relevant or less interesting and relevant than the average. This is coded in the deviation from  $interest_{PM}$ , and we assume this explains the student's Deep approach score in course C. As the scores of perceived Interest and relevance were centered on each student's own personal mean, Eq. (4) describes purely within-student variation.

In answering research question 2c (investigating how one's general perceptions of the TLE are related to course-specific approaches, over and above one's course-specific perceptions), we compared the between-student regression coefficient  $\gamma_{01}$  with the within-student regression coefficient  $\gamma_{10}$  (Eq. (11)). A statistically significant difference in the values of these two regression coefficients indicates that the effects of perceived interest and relevance differ on level 1 and level 2 of the multilevel model. Specifically, if  $\gamma_{01} > \gamma_{10}$ , the effect is stronger on the between-students level, and contrariwise if  $\gamma_{01} < \gamma_{10}$ . This type of analysis is known as an “analysis of contextual effects” (Snijders & Bosker, 2011, p. 122). In this study, it is the individual student that functions as the context for the course-specific analysis (Hoffman & Stawski, 2009). It may appear, at the first blush, counterintuitive that a difference in the two regression coefficients implies the existence of a contextual effect. This issue is discussed at length, using illustrative graphical examples, in Feaster et al. (2011), whose Method 1 model is conceptually and mathematically analogous to our contextual-effect model. Accordingly, we refer the interested reader to Feaster et al. (2011) and Hoffman and Stawski (2009) for more information on the modeling approach taken herein.

### 3. Results

#### 3.1. The stability versus variability in approaches to learning and in perceptions of the teaching-learning environment (RQ1)

The results concerning approaches to learning indicated that of the three approaches, organised studying had the most between-student variation (46%) and the least within-student variation (54%). There was much more within-students variation in deep approach (71%) and especially surface approach (85%), indicating that these approaches

**Table 2**  
Between-student and within-student variance for the dependent variables.

	Deep		Surface		Organised	
	Variance	% of var.	Variance	% of var.	Variance	% of var.
Between-students	0.155	28.97	0.095	15.06	0.381	45.79
Within-students	0.380	71.03	0.536	84.94	0.451	54.21
Total	0.535		0.631		0.832	

varied more across the courses. Table 2 shows the proportions of between- and within-student variance. The ICCs are shown in Tables 2 and 3 in the cell “% of Between-students variance”.

Out of the perceptions of the TLE (Table 3), Perceived interest and relevance varied across the courses the most (94% within-students variation) and Support from other students the least (64%). In the other perceptions, between-student variation ranged from 21 to 25%. It was thus ascertained that sufficient within-student and between-student variation existed both in approaches to learning and in perceptions of the TLE, rendering further analyses in the HLM reasonable. We then proceeded to examine how one's general tendency to perceive the TLE in a certain way is related to one's general tendency to adopt a certain approach (RQ 2a; between-student level) and how one's course-specific perception of the TLE is related to one's course specific approach to learning (RQ 2b; within-student level), and whether the regression coefficients at the two levels would differ in a statistically significant manner (RQ 2c).

**3.2. Students' general tendency to perceive the teaching-learning environment in a certain way as a predictor of their general tendency to adopt a certain approach (RQ 2a)**

RQ 2a examines perceptions of the teaching-learning environment and approaches to learning as stable characteristics of the students. To answer this question, we regressed student mean approaches to learning on student mean perceptions of the TLE as specified in Eq. (5).

To highlight the most relevant relations between general approaches and general perceptions of the TLE, we concentrated on the independent variables that explained most of the variance (> 10%) in the dependent variables (for all results, see Tables 4–6). Considered individually, in *deep approach* to learning, Teaching for understanding explained 27% ( $b = 0.57, p < .001$ ), Constructive feedback 24% ( $b = 0.43, p < .001$ ) and perceived Interest and relevance 20% ( $b = 0.40, p < .001$ ) of the between-student variation. All relations were positive and statistically significant. This means that, e.g., a general tendency to perceive that teaching promotes understanding was associated with an increase in the mean *deep approach* level.

All relations between *surface approach* to learning and perceptions of the TLE were negative, but not all of them were statistically significant. In *surface approach* to learning, Alignment of teaching explained 28%

**Table 3**  
Between-student and within-student variance for the independent variables.

	Interest and relevance		Teaching for understanding		Alignment		Enthusiasm		Constructive feedback		Support from other students	
	Variance	% of var.	Variance	% of var.	Variance	% of var.	Variance	% of var.	Variance	% of var.	Variance	% of var.
Between-students	0.058	6.20	0.112	23.93	0.126	25.40	0.088	21.26	0.147	22.48	0.207	35.88
Within-students	0.878	93.80	0.356	76.07	0.370	74.60	0.326	78.74	0.507	77.52	0.370	64.12
Total	0.936		0.468		0.496		0.414		0.654		0.577	

( $b = -0.49, p < .001$ ) and perceived Interest and relevance 23% ( $b = -0.40, p < .001$ ) of the between-student variation. Thus, when students generally perceived that their TLE was constructively aligned and when they felt that their studies were interesting and relevant, they were less likely to adopt a surface approach to learning. Notably, teachers' perceived enthusiasm, perception of receiving constructive feedback and perceived support from other students explained practically none of the level 2 variation in *surface approach*.

In *organised studying*, all of the TLE factors explained the between-student variation to some extent (and in a statistically significant manner), even though to a lesser extent than was the case for deep approach to learning. Perceived Interest and relevance explained 16% ( $b = 0.47, p < .001$ ), Constructive feedback 15% ( $b = 0.50, p < .001$ ) and Alignment of teaching 11% ( $b = 0.46, p < .001$ ) of the between-student variation. In other words, a tendency to score highly on these factors increased the level of *organised studying*.

**3.3. Course-specific perceptions of the learning environment as predictors of course-specific approaches to learning (RQ 2b)**

RQ 2b focused on within-student variation, i.e. variation in the students' scores from one course to another. In what follows, we concentrate again on the independent variables that explained most of the variance (> 10%) in the dependent variables (for all results, see Tables 4–6). In *deep approach* to learning, all relations between course-specific approaches and perceptions were positive and statistically significant. Considered individually, Teaching for understanding explained 22% ( $b = 0.40, p < .001$ ), perceived Interest and relevance 16% ( $b = 0.26, p < .001$ ), Constructive feedback 16% ( $b = 0.22, p < .001$ ) and Peer support 11% ( $b = 0.22, p < .001$ ) of the within-student variation in deep approach to learning. Thus, for instance, when the students perceived a given course as more interesting and relevant than usual, this was associated with higher than usual deep approach to learning on that course.

In *surface approach* to learning, all relations between course-specific approaches and perceptions were negative, even though not all of them were statistically significant. Within-student variation in surface approach was most strongly related to Alignment of teaching, which explained 20% ( $b = -0.42, p < .001$ ) of the variation. Perceived Interest and relevance explained 18% ( $b = -0.31, p < .001$ ) of the variation. This means that when students perceived that a specific course was aligned and that the course was interesting and relevant, their surface approach to learning decreased.

In *organised studying*, all relations were positive and statistically significant. Organised studying was most strongly related to perceived Interest and relevance, which explained 13% of the within-student variation ( $b = 0.26, p < .001$ ). Constructive feedback explained 11% ( $b = 0.17, p < .001$ ) and Alignment of teaching 10% ( $b = 0.32, p < .001$ ) of the variation. Thus when students scored highly on these factors in a specific course, their organised studying increased.

**Table 4**  
Fixed and random effects parameters for the models with Deep approach to learning as the dependent variable.

Parameter	Deep											
	Model 1a (Interest)		Model 1b (Teach for understand)		Model 1c (Alignment)		Model 1d (Enthusiasm)		Model 1e (Constructive)		Model 1f (Support)	
<b>Fixed effects</b>												
Intercept	3.010	(0.037)***	3.002	(0.036)***	3.011	(0.040)***	3.011	(0.039)***	3.009	(0.037)***	3.012	(0.038)***
Course 1	-0.416	(0.082)***	-0.534	(0.075)***	-0.567	(0.080)***	-0.650*	(0.078)***	-0.621	(0.078)***	-0.628	(0.079)***
Course 2	-0.377	(0.068)***	-0.327	(0.066)***	-0.396	(0.070)***	-0.333	(0.069)***	-0.369	(0.069)***	-0.370	(0.070)***
Course 3	-0.634	(0.074)***	-0.713	(0.069)***	-0.893	(0.074)***	-0.998	(0.077)***	-0.923	(0.074)***	-0.817	(0.073)***
Course 4	-0.333	(0.078)***	-0.401	(0.07)***	-0.604	(0.069)***	-0.691	(0.068)***	-0.700	(0.068)***	-0.619	(0.069)***
Within-students effect	0.264	(0.035)***	0.399	(0.045)***	0.265	(0.047)***	0.296	(0.051)***	0.224	(0.038)***	0.220	(0.043)***
Between-students effect	0.405	(0.069)***	0.566	(0.078)***	0.295	(0.083)***	0.376	(0.09)***	0.429	(0.068)***	0.329	(0.069)***
Contextual effect <sup>a</sup>	0.141	(0.076)'	0.166	(0.09)'	0.030	(0.095)	0.080	(0.102)	0.205	(0.077)**	0.109	(0.082)'
<b>Random effects</b>												
Within-students residual	0.244	(0.017)***	0.232	(0.016)***	0.258	(0.018)***	0.256	(0.018)***	0.257	(0.018)***	0.262	(0.019)***
Between-students residual	0.130	(0.024)***	0.118	(0.022)***	0.153	(0.027)***	0.147	(0.026)***	0.118	(0.023)***	0.136	(0.025)***
Reduction in level-1 variance	16.2%		21.6%		8.0%		9.5%		15.9%		10.6%	
Reduction in level-2 variance	20.3%		26.5%		8.8%		11.4%		24.4%		15.6%	
<b>Model summary</b>												
Deviance (-2LL)	933.5		901.1		973.5		967.8		948.1		970.4	
Δ deviance	82.9		115.2		42.9		48.5		68.3		46.0	
p (χ <sup>2</sup> )	< 0.001		< 0.001		< 0.001		< 0.001		< 0.001		< 0.001	

Standard errors for parameter estimates shown in parentheses.

\*\*\*  $p < .001$ .

\*\*  $p < .01$ .

\*  $p < .05$ .

'  $p < .1$ .

<sup>a</sup> Difference of between- and within-student effects.

**Table 5**  
Fixed and random effects parameters for the models with Surface approach to learning as the dependent variable.

Parameter	Surface											
	Model 2a (Interest)		Model 2b (Teach for understand)		Model 2c (Alignment)		Model 2d (Enthusiasm)		Model 2e (Constructive)		Model 2f (Support)	
<b>Fixed effects</b>												
Intercept	2.760	(0.035)***	2.766	(0.038)***	2.758	(0.034)***	2.760**	(0.039)***	2.759	(0.040)***	2.761	(0.040)***
Course 1	0.320	(0.087)***	0.515	(0.084)***	0.447	(0.082)***	0.594	(0.082)***	0.600	(0.086)***	0.635	(0.087)***
Course 2	0.552	(0.072)***	0.501	(0.074)***	0.591	(0.072)***	0.495	(0.074)***	0.534	(0.076)***	0.520	(0.078)***
Course 3	0.265	(0.078)***	0.397	(0.078)***	0.593	(0.076)***	0.701	(0.082)***	0.557	(0.081)***	0.489	(0.081)***
Course 4	-0.813	(0.083)***	-0.647	(0.078)***	-0.511	(0.071)***	-0.391	(0.072)***	-0.400	(0.075)***	-0.435	(0.077)***
Within-students effect	-0.314	(0.037)***	-0.344	(0.050)***	-0.416	(0.049)***	-0.373	(0.054)***	-0.164	(0.041)***	-0.032	(0.048)
Between-students effect	-0.404	(0.065)***	-0.312	(0.083)***	-0.492	(0.071)***	-0.193	(0.089)'	-0.057	(0.074)	-0.038	(0.072)
Contextual effect <sup>a</sup>	-0.089	(0.074)	0.032	(0.096)	-0.076	(0.086)	0.180	(0.104)'	0.107	(0.084)	-0.007	(0.086)
<b>Random effects</b>												
Within-students residual	0.278	(0.019)***	0.291	(0.020)***	0.276	(0.019)***	0.291	(0.020)***	0.313	(0.022)***	0.324	(0.023)***
Between-students residual	0.098	(0.021)***	0.122	(0.024)***	0.089	(0.02)***	0.134	(0.025)***	0.136	(0.026)***	0.134	(0.026)***
Reduction in level-1 variance	18.1%		9.8%		20.4%		7.2%		2.3%		0.2%	
Reduction in level-2 variance	23.1%		9.3%		27.7%		3.3%		0.6%		0.4%	
<b>Model summary</b>												
Deviance (-2 LL)	968.2		1009.0		958.1		1016.6		1050.1		1065.3	
Δ deviance	97.9		57.0		107.9		49.5		15.9		0.7	
p (χ <sup>2</sup> )	< 0.001		< 0.001		< 0.001		< 0.001		< 0.001		0.698	

Standard errors for parameter estimates shown in parentheses.

\*\*\*  $p < 0.001$ .

\*\*  $p < .01$ .

\*  $p < .05$ .

'  $p < .1$ .

<sup>a</sup> Difference of between- and within-student effects.

**Table 6**  
Fixed effects parameters for the models with Organised approach to learning as the dependent variable.

Parameter	Organised											
	Model 3a (Interest)		Model 3b (Teach for understand)		Model 3c (Alignment)		Model 3d (Enthusiasm)		Model 3e (Constructive)		Model 3f (Support)	
<b>Fixed effects</b>												
Intercept	2.736	(0.055)***	2.732	(0.058)***	2.737	(0.057)***	2.739	(0.058)***	2.734	(0.056)***	2.741	(0.058)***
Course 1	0.316	(0.100)**	0.177	(0.093)*	0.201	(0.094)*	0.087	(0.093)	0.103	(0.094)	0.132	(0.091)*
Course 2	0.409	(0.081)***	0.454	(0.081)***	0.379	(0.082)***	0.452	(0.082)***	0.422	(0.083)***	0.401	(0.081)***
Course 3	0.046	(0.089)	-0.047	(0.086)	-0.223	(0.086)*	-0.301	(0.092)**	-0.214	(0.089)*	-0.129	(0.084)
Course 4	0.120	(0.094)	0.024	(0.086)	-0.131	(0.08)	-0.226	(0.081)**	-0.227	(0.082)**	-0.136	(0.079)*
Within-students effect	0.256	(0.042)***	0.346	(0.055)***	0.324	(0.055)***	0.276	(0.06)***	0.172	(0.045)***	0.331	(0.049)***
Between-students effect	0.471	(0.101)***	0.314	(0.128)*	0.456	(0.118)***	0.418	(0.131)**	0.495	(0.103)***	0.227	(0.106)*
Contextual effect <sup>a</sup>	0.215	(0.109)*	-0.032	(0.139)	0.132	(0.13)	0.142	(0.144)	0.323	(0.112)**	-0.104	(0.117)
<b>Random effects</b>												
Within-students residual	0.348	(0.025)***	0.344	(0.024)***	0.349	(0.025)***	0.359	(0.025)***	0.364	(0.026)***	0.341	(0.024)***
Between-students residual	0.340	(0.052)***	0.393	(0.058)***	0.361	(0.054)***	0.379	(0.056)***	0.339	(0.052)***	0.393	(0.058)***
Reduction in level-1 variance	12.8%		6.7%		10.1%		6.6%		10.9%		7.0%	
Reduction in level-2 variance	15.7%		5.0%		11.3%		7.3%		15.3%		5.0%	
<b>Model summary</b>												
Deviance (-2 LL)	1190.4		1201.8		1197.4		1215.2		1209.6		1197.8	
Δ deviance	54.9		43.4		47.8		30.1		35.7		47.5	
p (χ <sup>2</sup> )	< 0.001		< 0.001		< 0.001		< 0.001		< 0.001		< 0.001	

Standard errors for parameter estimates shown in parentheses.

\*\*\*  $p < .001$ .

\*\*  $p < .01$ .

\*  $p < .05$ .

·  $p < .1$ .

<sup>a</sup> Difference of between- and within-student effects.

### 3.4. General tendency to perceive the learning environment in a certain way as a predictor of a course-specific approach to learning over and above one's course-specific perceptions of the TLE (RQ 2c)

Research question 2c asked how one's general tendency to perceive the TLE in a certain way is related to one's *course-specific* approaches to learning while controlling for the students' perceptions of the TLE in that specific course. RQ 2c was answered by examining the differences in the between- and within-student regression slopes.

The results showed that general perceptions of Constructive feedback predicted variation in deep approach to learning ( $b = 0.21$ ,  $p < .01$ ) as well as in organised studying ( $b = 0.32$ ,  $p < .01$ ) at the course level positively and statistically significantly when controlling for the course-specific perceptions (see Tables 4–6). In addition, general perceptions of interest and relevance predicted variation in organised studying ( $b = 0.22$ ,  $p < .05$ ) at the course level positively and statistically significantly when controlling for the course-specific perceptions. To give an example: two students participating in the same course perceived interest and relevance in that particular course similarly, but their general perceptions of interest and relevance were different. Due to this, the student with a higher score in general perceived Interest and relevance scored higher in organised studying in this particular course.

In Tables 4–6, the row 'Contextual effect' indicates the effect that the student's overall mean in the TLE variables had on the approaches to learning for a certain course, over and above the effect of the course-specific value of the teaching-learning variable.

## 4. Discussion

### 4.1. Within-student and between-student variation in approaches to learning

The results add to the discussion about the variability of the approaches to learning, and how this variation is related to students' perceptions of the TLE. First we examined the variation in students'

approaches to learning at both the within-student level (individual variation) and between-student level (group-level variation). This approach to data analysis provided new insights into the debate on the stability (e.g. Lietz & Matthews, 2010; Zeegers, 2001) vs. variability (e.g. Baeten et al., 2010; Coertjens et al., 2016; Nieminen et al., 2004; Vermunt, 2005) of approaches to learning by showing that organised studying had the least within-student variation and thus did not vary between courses to the same extent as deep and surface approaches (RQ 1). This implies that organised studying is not as context-specific as deep and surface approaches but instead might be more related to students' individual characteristics. This is in line with the finding that students' ability to manage their time and effort in their first study year predicts their time and effort management during their third year of studying (Parpala, Asikainen, Ruohoniemi, & Lindblom-Ylänne, 2017). The stability of organised studying might, however, be partly due to the similarity of the course contexts. Thus, the stability of organised studying could be explained not only by individual characteristics but also by the constant factor in the educational context (see Richardson, 2013), i.e. teaching with a focus on lecturing. More variation in organised studying could have been detected if there were more variation between the teaching-learning environments in the different courses and even more, if the courses would represent different disciplines. More within-student variation was found in surface and the deep approaches to learning, indicating that the course context and characteristics of the TLE had a larger impact on the adoption of these approaches. Thus the results indicate that approaches to learning, especially deep and surface approaches, do vary more from one course to another and can be affected by the characteristics of the TLE.

### 4.2. Within-student and between-student variation in perceptions of the TLE

Second, the study also examined the ratio of within- and between-student variation in the students' perceptions of their TLE. Most of the variation in all perceptions of the TLE occurred at the within-student level, i.e. from one course to another. This was most readily apparent in



the case of perceived Interest and relevance, and least so in the case of Support from other students. The latter might then be more related to characteristics of individual students in that some students seek more support from other students, while others may prefer studying alone and do not consider such support as important for their learning. For example, in a recent study, Räsänen, Postareff, and Lindblom-Ylänne (2016) found that students with excellent self-regulation skills and deep-level processing did not emphasise the importance of peer support from other students but instead preferred studying alone.

#### 4.3. Relations between approaches to learning and perceptions of the TLE

Our next research question focused on how the students' general tendency to adopt a certain approach to learning was predicted by their general tendency to perceive the TLE in a certain way (RQ 2a). First, we found that perceptions of interest and relevance were a potential predictor of between-student variation in all three approaches: deep, surface and organised studying. Thus, enhancing the students' perceptions of interest and relevance could be a way to increase their deep approach and organised studying and decreasing their use of surface approach to learning. These observations are in line with those of Coertjens et al. (2016) when it comes to the surface approach and organised studying, even though a relationship with deep approach was only found in the present study. Practical measures to enhance the students' perceived interest and relevance might include, e.g., clarifying how different courses are related to each other, how the courses together build up their understanding of the discipline and what kind of expertise the studies as a whole develop. Further, the students' perception of receiving constructive feedback increased both their overall deep and organised approach to studying while having little effect on their surface approach. Finally, an overall positive perception of alignment decreased the students' surface approach and increased their organised studying while having a lesser effect on their deep approach. Within-student variation in approaches to learning (RQ 2b) was best predicted by largely the same variables as between-student variation, with the best predictors for an increase in deep approach being positive perceptions of Teaching for understanding, Interest and relevance, and Constructive feedback. In short, it appears that enhancing the students' perceptions of these three elements of the TLE might bring about desirable changes in their approaches to learning. The results of the present study support the view of Asikainen et al. (2014) that at the within-student level an increase in deep approach might be related to an increase in positive perceptions of the TLE, while a decrease in deep approach might be related to an increase in negative perceptions of the TLE.

It must be kept in mind that the relation between approaches and perceptions of the TLE might be bidirectional. Thus, for example, an increase in students' deep approach and organised studying in general, or on individual courses, may have an effect on scores in their perceptions of interest and relevance, constructive feedback and alignment. Therefore, it is equally important to try to support students' deep and organised studying and to make the subject matter more interesting, give more constructive feedback and try to clarify the aims of the teaching.

#### 4.4. The relations between general perceptions of the TLE and course-specific approaches to learning

Our last research question (RQ 2c) concerned how students' general tendency to perceive the TLE is related to their course-specific approaches to learning. The question was answered by examining how a general tendency to perceive the TLE in a certain way predicts course-specific approaches to learning over and above one's course-specific perceptions of it. Again, perceiving the subject matter as interesting and relevant seems to be a potential predictor of an increase in organised studying, although this time the focus was on general perceptions and

course-specific approaches. The key to interpreting this result might be found by considering the qualities of students who are, overall, interested in the subject matter they are studying. One obvious candidate is the students' motivation. As previous studies have shown, intrinsic motivation is usually positively related to both organised studying and a deep approach to learning (see e.g. Moneta & Spada, 2009; Prat-Sala & Redford, 2010). The present result may thus indicate that students who are in general highly motivated to study at the university are more likely to adopt an organised approach to studying at a specific course, even when controlling for their perception of the interest and relevance of that specific course. However, as mentioned previously, the relation might be bidirectional, and therefore, both perceptions and approaches must be taken into account in enhancing students' organised studying. Furthermore, perception of generally receiving constructive feedback predicted an increase in the deep approach to learning and organised studying at the course level. This makes sense, since feedback has been shown to have several beneficial consequences for students' learning, such as self-monitoring and regulation of actions and understanding of what processes are needed to perform tasks. Furthermore, constructive feedback has a positive influence on one's evaluations of own abilities as a learner (Hattie & Timperley, 2007). To conclude, based on the results of this study we can hypothesize that the students' general tendency to perceive that they receive constructive feedback and perceive their studies as interesting and relevant has an effect on their approaches to learning over and above their course-specific perceptions.

#### 4.5. Methodological perspectives

The present results may be partly explained by considering what the presently used questionnaires in fact measure. Some of the items intended to measure Interest and relevance might be interpreted as being related to the students' level of motivation (e.g. "I find most of what I learned in courses really interesting"). Further, the relationship of the perception of receiving constructive feedback and the approaches to learning might be partly explained by the semantic contents of the questionnaire items related to the former: the items seem both related to receiving feedback but also to the ability to understand its value (e.g. "The feedback given on my set work helps to clarify things I hadn't fully understood"). Therefore, the item could be seen to also measure the ability to monitor understanding, which is empirically related to a deep approach (Entwistle & McCune, 2004). To sum up, the scale Constructive feedback as well as Interest and relevance may not only measure the students' perceptions of the TLE but also their own learning.

On the basis of the results of the study, it could be argued that it makes little difference whether approaches to learning and perceptions of the TLE are explored at the course level or at a more general level across courses, because similar relationships were observed on both levels. Still, most of the regression coefficients were larger at the between-student level, some of them sufficiently so to give rise to contextual effects. A major benefit of studies with multiple measurement points based on hierarchical linear models, such as the present one, is that they allow asking: "Do the relationships that have been found when exploring differences between people apply also as descriptions within a single person?" This is an important question, because it is in principle possible that even a reverse relationship exists in these two cases. For instance, when someone exercises more than the average person, he or she is likely to be healthier than the average person as well; still, if the same person exercises more than he or she does on average, the increase in exercise may conceivably be associated with even adverse health effects. In the current study, all the within-students and between-students regression coefficients were of the same sign, and in all cases in which the between-students regression coefficient differed statistically from zero, the within-students regression coefficient did as well. In short, we did not observe that the between-students

relationships would have changed sign or disappeared at the within-students level; in other words, no evidence for Simpson's paradox was found concerning the relationships examined in this study. The current results thus add support to the idea that the relationships found in previous studies concerning the associations between the perceptions of the TLE and the approaches to learning can be interpreted as applying to individual students as well.

It should be noticed that the students' 'general' approach to learning and 'general' perceptions were operationalised as the average scores of their approaches and perceptions in the different courses. Thus, the general approach and general perceptions could vary if more or other courses were included in the average score.

#### 4.6. Limitations of the study

It must be kept in mind that the results of the study do not confirm whether perceptions affect the variation in approaches or whether the adoption of a certain approach affects students' perceptions of the TLE. However, previous interview-based studies have provided evidence of the effect of the TLE on approaches to learning. Students whose approaches vary between contexts have been shown to be vulnerable to the characteristics and demands of the TLE (Postareff et al., 2014; Postareff et al., 2015). On the other hand, students whose approaches remain more stable over contexts seem to be resistant to the effects of their TLE. Instead, individual qualities such as a well-developed use of learning strategies and good self-regulation skills appear to be typical to these students (Lindblom-Ylänne & Lonka, 1999; Postareff et al., 2014). Previous studies have highlighted the role of intrinsic motivation, self-confidence, self-efficacy beliefs and openness to experience in enhancing the application of a deep approach (Baeten et al., 2010; Kyndt, Dochy, Struyven, & Cascallar, 2011).

One specifically methodological limitation of the present study relates to our use of multiple separate univariate models. This decision was made to be able to assess the contextual effects for each predictor separately, i.e. to assess whether there would be evidence for Simpson's paradox for any of the predictors. In future studies it may well be a viable strategy to base similar analyses on multivariate or multivariable models. However, the choice of the predictors to include – or, in other words, of third variables to control for – must always depend on domain knowledge concerning potential causal pathways among the variables. Basing such analysis on using directed acyclic graphs (DAGs), and explicitly considering the modelled variables as mediators, colliders or confounders would be beneficial in future studies (Rohrer, 2018).

As a further limitation of this study it can be noted that an analysis of the between-student and within-student measurement invariance (Millsap, 2011) of the approaches to learning and perceptions of the TLE scales was not carried out. That is, we assumed that the scales can be used to measure equivalent constructs both over time and over different persons. A recent summary of these issues can be found in Adolf, Schuurman, Borkenau, Borsboom, and Dolan (2014); for now, suffice it to say that it is entirely possible that “different people exhibit different patterns of change over time, which are governed by different latent variable structures” (Borsboom et al., 2003, p. 215) and that whether this is the case or not is “one of the big unknowns in psychology” (Ibid.).

Setting aside the question of measurement invariance, in future studies it would be of interest to directly model the amount of within-student variance (for instance, the residual variance  $e$  of our Eq. (4)) in a multilevel model. That would necessitate several measurement occasions, preferably at least 10 of them (Hoffman, 2007, p. 619). Further, even in a study like the present one, it would be beneficial to include a greater number of measurement occasions. This would produce a more accurate estimate of the students' mean level of independent and dependent variables. In addition, it would enable more flexibility in the choice of models: for instance, measurement occasions (individual courses) could be treated as a sample from a population of

potential courses, and modelled as a random variable. Further, if change (rather than fluctuation) of the approaches to learning is to be modelled in future studies, it is of paramount importance to ensure by careful experimental design that extraneous factors do not influence the measurements. For instance, if counterbalancing the order in which the courses are taken would be feasible in practice, this would help to avoid effects related to the order of the courses.

The possibility of the within-student variance being due to measurement error cannot be ruled out in the present study. This is because – and to borrow terminology from Borsboom et al. (2003) – we have currently no way of knowing whether the latent variables in question are locally homogenous, locally heterogeneous or locally irrelevant. That is, we do not know whether the within-subject latent variables are the same or different from those at the between-subjects level. Answering the question would require intensive longitudinal data on each individual respondent (at the order of dozens or hundreds of within-subject measurements) and the calculation of separate latent variable models for each individual respondent based on within-subject variance across time. Borsboom et al. (2003) go as far as to suggest that this is likely not true for most phenomena in psychology, and we think that investigating the question using suitable intensive longitudinal data is of utmost importance in educational psychology, as well.

The results of the present study cannot be generalised without critical evaluation of the context in which it was conducted. This study was conducted in only one disciplinary context, pharmacy. Previous research has identified disciplinary differences in students' approaches to learning (e.g. Parpala et al., 2010), showing that students in hard sciences such as pharmacy are more likely to adopt the surface approach than students in soft sciences. Furthermore, the data was collected from courses consisting mainly of teacher-focused lecturing. Thus, the variability of approaches to learning among students in other disciplinary fields and in more activating course contexts might differ from what was shown in this study. For example, more variation in teaching methods and levels of student activation between the courses would likely result in more within-student variation in approaches to learning. Furthermore, some of the data was collected during the last contact session and some data after the final exam. This might have an effect on the results since students often experience positive or negative emotions related to assessment (Pekrun, Elliot, & Maier, 2009). Thus, they might evaluate their own approaches to learning or their perceptions of the TLE more positively if they have a good experience of the course assessment, and vice versa, negative experiences of assessment might result in more negative self-reports. On the other hand, assessment is an integral part of the teaching-learning process, and if data is collected before the final assessment of the course, the students' experience of the whole course remains incomplete. Unfortunately, we did not have an opportunity to further analyse the effects of whether students responded before or after the final exam, which is a clear limitation of the study and should be noted in generalising the results. Finally, it is worth noticing that we did not assume there to be systematic change (linear increase or decrease) in the values from one course to another, because we modelled differences in SAL values as fluctuation around the students' personal means. Thus, the fact that courses 3 and 4 were close to one another in time, was not considered as an important weakness of the study. However, this is an important aspect when interpreting the results and generalising them to contexts where systematic change is assumed.

## 5. Conclusions

In encouraging students to adopt the deep approach to learning and discouraging the use of surface approach, it is important to develop both individual courses and teaching on a more general and institutional level. This can be done by enhancing the perceived interest and relevance of studying, providing teaching that promotes the students' deep understanding (e.g. through encouraging reflective and critical

studying) and follows the principles of constructive alignment in that the teaching and assessment methods support students to deeply learn what is stated in the learning objectives of courses (Biggs, 1996). It is particularly important to provide constructive feedback to students across courses, as the general perception of constructive feedback seems to predict variation in the students' course-specific deep and organised approaches to learning.

Finally, we wish to especially emphasise the results concerning organised studying, which in the light of recent research is an important factor supporting successful studying at university (Asikainen et al., 2014; Haarala-Muhonen, Ruohoniemi, Parpala, Komulainen, & Lindblom-Ylänne, 2017). The present results imply that organised studying is more stable across courses than the deep and surface approaches, and thus might be more related with individual characteristics and consequently potentially more difficult to influence. Negotiating about the goals and mid-goals of the course together with the students, showing how much effort is needed to complete the course and encouraging them to reflect on their own study processes and progress during the course would be effective ways to support organised studying.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.lindif.2018.10.006>.

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