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Relations between student learning patterns and personal and contextual factors and academic performance

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Abstract. This study was aimed at clarifying relations between the way students learn and personal, contextual and performance variables. Students from seven different academic disciplines completed the Inventory of Learning Styles (ILS). Besides, data about their age, gender, academic discipline, prior education and exam performance were gathered. Regression and correlations analyses were used to analyse the data. The results showed that students' learning patterns were indeed associated with personal and contextual factors such as academic discipline, prior education, age and gender, but that the different learning patterns had different sources. Second, students' learning patterns proved to explain an important part of the variance in their academic performance. However, the results also revealed that exams as usually used in the first years of higher education hardly capitalise on students' use of critical, analytical and concrete processing strategies.

Keywords: academic performance, contextual influences, learning strategies, learning style, personal factors, student learning.

Introduction

Various factors in the learning environment and in the students themselves affect the way they go about learning and studying. Entwistle (2000) describes a model in which he discerns three groups of influencing factors on student learning: students characteristics, teaching characteristics, and departmental characteristics. Among the student characteristics he mentions prior knowledge, intellectual abilities, learning style, personality, attitudes to courses, motivation, work habits, and study skills. Teaching characteristics encompass level, pace, structure, clarity, explanation, enthusiasm, and empathy of teaching. To departmental characteristics belong course design and objectives, learning materials, assessment procedures, workload, freedom of choice, and study skills support. Recently, Entwistle et al. (2003) expanded this model to include a broader range of teaching–learning environments in higher education.

The way students learn can be conceptualised in various ways (Entwistle et al. 2001). In most conceptualisations, deep and surface approaches to learning play an important role. Moreover, different forms of student motivation or orientation are part of most conceptualisations, e.g. the difference between intrinsic and extrinsic motivation. Sometimes, students views on learning and good teaching are part of the concept of student learning, for example constructive and reproductive conceptions of learning. Recently, regulation of student learning has also become a part of some models of student learning, e.g. self-regulation and external regulation of learning. A thorough discussion of the different conceptualisations of student learning is beyond the scope of this article. Entwistle and McCune (2004) give an overview of several of these conceptualisations and associated inventories. Interesting reviews about this issue have also been published by Richardson (2000) and Lonka et al. (2004).

This article focuses on relations between student learning patterns and personal, contextual and performance variables. A student learning pattern is conceptualised here as defined by a students' position on four learning components: cognitive processing strategies, metacognitive regulation strategies, conceptions of learning, and learning orientations. In earlier research using the Inventory of Learning Styles (ILS) (see below), four such patterns were repeatedly found: meaning directed learning, reproduction directed learning, application directed learning, and undirected learning (Vermunt 1996, 1998; Busato et al. 1998; Boyle et al. 2003). Meaning-directed learning is typified by relating, structuring, and processing the subject matter critically, self-regulation of learning processes and contents, construction of knowledge as learning conception, and personal interest as learning orientation. Memorising and rehearsing, analysing, external regulation of learning, certificate- and self-test-directed learning orientations, and a learning conception in which learning is viewed as the intake of existing knowledge are characteristic of reproduction-directed learning. Concrete processing, a vocational learning orientation, and a learning conception stressing the use of knowledge characterise application-directed learning. Undirected learning is typified by lack of regulation, an ambivalent learning orientation, and a learning conception in which great value is attached to cooperation with fellow students and to stimulating education.

In previous publications my colleagues and I used the term learning 'style' for this pattern. However, in the last decade there has been a big debate about terminology in the field of student learning, in which Entwistle has played a prominent role (see, e.g. Entwistle et al. 2001;

Entwistle and McCune 2004). The disadvantage of the term 'style' is that too often people associate it with unchangeability, an invariant attribute of students, deeply rooted in personality. Since our research group conceives learning style definitely '*not* as an unchangeable personality attribute, but as the result of the temporal interplay between personal and contextual influences' (Vermunt 1996, p. 29), in this article the more neutral term learning 'pattern' will be used for the same phenomenon we used to describe with learning style.

Personal and contextual variables

As stated above, the way students learn is the result of the interaction between the person and his or her environment (see also Geisler-Brenstein et al. 1996). Personal influences cause consistency in the way students learn, environmental, or contextual influences are responsible for variability.

Busato et al. (1999) studied relations between learning style and personality among Psychology students. The most striking relations were between meaning directed learning and intellectual openness, and between reproduction directed learning and conscientiousness and agreeableness. A study by Vermetten et al. (2001) yielded comparable results.

Regarding epistemologies, Rozendaal et al. (2001) found that students with a more relativistic view of knowledge were more meaning directed in their learning. Students with a more absolutistic view of knowledge were more likely to report reproduction-directed and undirected learning patterns.

Age may be another influencing variable. Rather generally it is assumed that there are big differences between younger and older people in their learning. These differences pertain to someone's position in society, the larger amount of life experience that adults bring with them to a learning situation, learning motivation and learning ability. However, these described differences are only to a small degree based on empirical comparative research, and therefore have a highly ascribed nature.

It is possible that gender-bound differences in for example upbringing, average position in society, having paid jobs etc., exert influence on the way in which men and women are inclined to learn (Richardson 2000). Severiens and Ten Dam (1997) studied the relation between learning styles and gender. They found that men, on average, scored higher than women on undirected learning, while women scored higher than men on reproduction-directed learning. Zeegers (2001), however,

found no differences between male and female students in their approaches to learning.

Besides personal influences there are also some contextual factors related to the learning activities that students employ. The most important and direct one, the way in which instruction and teaching are conducted, is not the focus of the present study (see for example Trigwell et al. 1999; Vermunt and Verloop 1999; Vermunt 2003). Research on more general contextual factors has focused on, for example, disciplinary differences (Ramsden 1988; VanderStoep et al. 1996), differences in educational experience, and differences between campus-based and distance education (Richardson et al. 1999).

An important contextual variable is students' educational experience, both with respect to the level of prior education as to the nature of the learning environments in which they have much experience. According to Marton and Säljö (1997), people's learning conceptions originate in their experiences with learning and participating in education and training. In their study mainly students with little educational experience, irrespective of age, showed reproductive views on learning. They suggested that increasing experience in formal education goes together with a development in conceptions and views people have about learning. Especially the transition from secondary to higher education is an experience that contributes to this development. Their study showed that the sudden confrontation with thousands of pages of study materials was a shock for many inexperienced students. For a number of them this was an encouragement to wonder what they were supposed to learn from this mass of information and how that could best be done.

The nature of the academic discipline is supposed to influence the kind of thinking strategies students use to learn. Different disciplines would pose different demands on the way subject matter can best be studied. Subject matter within the natural sciences is often hierarchical, logical, and directed at rules and procedures. Such domains require more than other domains a thorough, analytical processing strategy to be able to reach understanding of the subject matter. In language learning students often use memorising word meanings as a learning strategy. Subject domains in which large amounts of texts should be processed call more for relating and structuring learning activities. Ramsden (1988) found empirical support for these assumptions in a study with British university students. Students from the Natural and Technical sciences, for example, scored highest of all students on serialistic learning, while students from the Arts and Social Sciences scored highest on holistic learning. In the discussion about the domain

specificity of learning and thinking strategies, it is assumed that although these strategies can be described in general terms, they need domain specific adjustments to be able to function optimally.

Academic performance

'Learning' is conceptualised here as developing a way of thinking and acting that characterises the culture of a professional community. It is seen as an active process in which the learner construes, modifies and utilises mental models of the subject domain to interpret situations in that domain and to act in them. Therefore, learning activities play a central role. The quality of the learning activities that students undertake, it is supposed, determines to an important extent the quality of the learning results they achieve. Similar assumptions underlie the constructivist school of thought that arose about a decade ago. The way in which the quality of learning results should be measured is a central point of attention for constructivism. Cunningham (1991), for example, dismisses the use of traditional tests and suggests to look at the learning activity and task performance itself, and at the capability of the learner to reflect on this activity.

The relation between learning activities and domain specific learning outcomes has been studied. It is important to make a difference between learning results and exam achievements in this regard. Too often the latter only reflect a small portion of the former. For the exam achievements it sometimes does not matter very much what kind of thinking strategies a students has used when learning. For example, a processing strategy in which searching for relations within the subject matter is stressed, and a strategy in which more use is made of concretising learning activities, can both lead to a good understanding of the subject matter. Memorising too can lead to passing an exam. This is, of course, highly dependent on the way in which learning outcomes are measured and valued by the teachers.

A central issue in this article is, therefore, to what extent the exams that are usual in the first years of higher education capitalise on the various learning activities that students employ. Some research has been conducted on relations between approaches to learning and exam results in higher education. For example, Meyer et al. (1990) studied, with students at a technical university, the relations between students' scores on Entwistle's Approaches to Studying Inventory and their mean exam scores. Busato et al. (1998) found that undirected learning was

negatively related to academic performance. Meaning-directed learning showed a positive association with performance and the other two patterns (reproduction-directed and application-directed learning) showed no relation. The same pattern of relationships was found by Boyle et al. (2003). For medical students, meaning-directed learning was positively related to both preclinical and clinical study achievements, as shown by Lindblom-Ylänne and Lonka (1999). In their study, reproduction-directed learning was negatively associated with achievements. In a study with students' portfolio grades in an innovative course, meaning-directed learning correlated positively and reproduction directed learning correlated negatively with achievement (Lonka et al. 1997). Meyer (2000) showed that especially 'dissonant' student learning patterns were associated with low exam performance.

With regard to the processing of subject matter, research has shown that thinking activities belonging to a deep approach, such as relating, structuring, and concretising, lead to qualitatively better learning outcomes than memorising learning activities used within a surface approach (Trigwell and Prosser 1991). Performing regulation activities oneself leads to better learning achievements in situations in which there is little external regulation, than not performing these activities (De Jong 1995). But too little is known about the relation between affective learning activities and learning outcomes to justify any conclusion. Relations between learning activities and domain specific learning outcomes turn out to vary according to, for example, academic discipline, the level of the courses and course characteristics.

The present study

Many of the studies described above studied the influence of personal and contextual factors on students' ways of learning in isolation from other factors. In publications in which such relations are reported, this often happens in the form of singular correlations, without correcting, for example, for the relation between age and prior educational level. Similarly, although the studies described above have revealed some insights into the relations between student learning and academic performance, they often are restricted in their scope. Almost always only one or two academic disciplines are included in the study. Moreover, often only one indicator for academic performance is used, such as mean exam score or passing/failing a particular course. Third, most of the time, students' processing strategies and learning orientations are

measured and included as variables, but not their regulation strategies and learning conceptions.

A first main purpose of the analyses that are presented in this article is to study the relations of several relevant personal and contextual factors with students' learning patterns *simultaneously,* in a comprehensive model. In this way, relations of these predictor variables with learning patterns variables are corrected for their intercorrelations. In these analyses learning patterns are considered as dependent variables compared to various personal and contextual factors as independent variables.

A second main purpose is to gain insight into the relationships of both processing and regulation strategies, and both learning orientations and learning conceptions, with different indicators for exam results, in different types of academic disciplines. Indicators used for exam results will be: mean exam score, percentage of exam passed, and study pace. Academic disciplines include Economical sciences, Law, Arts, Psychology and Sociology.

The present study aimed to answer the following research questions:

(1) How are student learning patterns related to personal variables such as age and gender, and contextual variables like prior education and academic discipline?
(2) How are student learning patterns related to different indicators for academic performance (mean exam scores, percentage of exams passed, and study pace) within different academic disciplines?

Method

Students

The study was conducted at a middle size university in the Netherlands. A sample of 1279 students was drawn from the population of 2530 students that had not yet passed the first year propaedeutic exam of their current academic discipline. In six of the eight academic disciplines the whole population was included in the sample. Because of the large numbers of first year students of Economy and Law a random sample of 200 students was drawn for these disciplines. A fully completed ILS (see below) was received from 795 students (62% response). In Table 1 the distribution of these students over the personal and contextual variables is shown. Because of the small number of responses from students of Philosophy in the response group (N = 3), these students are left out of all analyses.

Table 1. Frequencies (N) and percentages of the values on the predictors gender, level of highest completed prior education, and academic discipline, and means and standard deviations on the predictor age

Predictors	M and SD	N	%
Age			
Mean	22.5		
Standard deviation	6.2		
No value		18	2.3
Gender			
0: Men		446	56.3
1: Women		345	43.6
No value		1	0.1
Level highest completed prior education:			
1: Secondary education		592	74.7
2: Higher vocational education		147	18.6
3: University education		8	1.0
No value		45	5.7
Academic discipline			
Law		100	12.6
Management Information science		77	9.7
Economy		133	16.8
Econometry		112	14.1
Sociology		105	13.3
Psychology		189	23.9
Arts		73	9.2
No value		3	0.4
Total number		792	100.0

Inventory of learning styles

In this study the ILS was used (Vermunt 1998). The ILS consists of 120 statements that cover 4 learning components: cognitive processing strategies, metacognitive regulation strategies, conceptions of learning, and learning orientations. For the strategy items, students are asked to indicate on a five-point scale the degree to which they use the described learning activities in their studies. The scale varies from (1) I seldom or never do this, to (5) I (almost) always do this. For the items on learning conceptions and learning orientations, students are asked to indicate on a five-point scale the degree to which the described views and motives

correspond to their own views and motives. Here the scale varies from (1) completely disagree to (5) completely agree. The ILS generates 20 scale variables: five processing strategies, five regulation strategies, five conceptions of learning, and five learning orientations. These ILS scales and their content are described in Table 2. In several studies, the

Table 2. Scales of the Inventory of Learning Styles (ILS) and their content

Parts and scales of the ILS	Description of content
Processing strategies	
Deep processing	
Relating and structuring	Relating elements of the subject matter to each other and to prior knowledge; structuring these elements into a whole
Critical processing	Forming one's own view on the subjects that are dealt with, drawing one's own conclusions, and being critical of the conclusions drawn by textbook authors and teachers
Stepwise processing	
Memorising and rehearsing	Learning facts, definitions, lists of characteristics and the like by heart by rehearsing them
Analysing	Going through the subject matter in a stepwise fashion and studying the separate elements thoroughly, in detail and one by one
Concrete processing	Concretising and applying subject matter by connecting it to one's own experiences and by using what one learns in a course in practice
Regulation strategies	
Self-regulation	
Learning process and results	Regulating one's own learning processes through regulation activities like planning learning activities, monitoring progress, diagnosing problems, testing one's results, adjusting, and reflecting
Learning content	Consulting literature and sources outside the syllabus
External regulation	
Learning process	Letting one's own learning processes be regulated by external sources, such as introductions, learning objectives, directions, questions or assignments of teachers or textbook authors

Table 2. Continued

Learning results	Testing one's learning results by external means, such as the tests, assignments, and questions provided
Lack of regulation	Monitoring difficulties with the regulation of one's own learning processes
Conceptions of learning	
Construction of knowledge	Learning viewed as constructing one's own knowledge and insights. Most learning activities are seen as tasks of students
Intake of knowledge	Learning viewed as taking in knowledge provided by education through memorising and reproducing; other learning activities are tasks of teachers
Use of knowledge	Learning viewed as acquiring knowledge that can be used by means of concretising and applying. These activities are seen as tasks of both students and teachers
Stimulating education	Learning activities are viewed as tasks of students, but teachers and textbook authors should continuously stimulate students to use these activities
Co-operative learning	Attaching a lot of value to learning in co-operation with fellow students and sharing the tasks of learning with them
Learning orientations	
Personally interested	Studying out of interest in the course subjects and to develop oneself as a person
Certificate-oriented	Striving for high study achievements; studying to pass examinations and to obtain certificates, credit points, and a degree
Self-test-oriented	Studying to test one's own capabilities and to prove to oneself and others that one is able to cope with the demands of higher education
Vocation-oriented	Studying to acquire professional skill and to obtain a(nother) job
Ambivalent	A doubtful, uncertain attitude toward the studies, one's own capabilities, the chosen academic discipline, the type of education, etc

internal consistencies of these scales turned out to vary between .48 and .89 for regular university students and between .67 and .93 for Open University students. In 33 of the 40 cases, the scales had alphas of .70 or higher (see Vermunt 1998).

Personal, contextual and performance variables

Prior to completing the ILS students were asked some questions about their background and study characteristics and their exam results. As an indicator of their prior education students were asked to indicate the education they had completed before they had started their current studies, and the highest certificate or diploma they had attained in their education. Questions were also asked about their current academic discipline, date of birth and gender. To indicate academic performance, students were asked for the year in which they first registered for their current academic discipline, the courses they had followed until then, and the exam scores they had attained for these courses.

Procedure

The ILS was sent to all students from the sample, together with a covering letter and a post-paid return envelope. Three weeks later a reminder was sent to all students who had not reacted by then. Participation in the study was voluntary and the respondents were in no way rewarded for their cooperation.

Data analysis

Question 1

Data were analysed via regression analysis, using the SPSS statistical package. The following variables were created for the various personal and contextual factors: (1) Age; (Based on the date of birth students had indicated, a continuous variable 'age' was created.) (2) Gender; (To make this categorical variable fit for entering into a regression analysis, it was recoded into a (0, 1) variable.) (3) The highest level of completed prior education; (This was represented by a variable with three values: secondary education, higher vocational education, and university education. Students were assigned to one of these categories based on a

combination of their last education and the highest certificate or diploma attained at this education. Because of the hierarchical nature of this variable, it was decided to recode it into a continuous variable rather than into a set of Dummy variables.) (4) Academic discipline; (Students were assigned to the discipline they had indicated on the questionnaire. To make this categorical variable fit for entering into the regression analysis, Dummy variables were created that represented the various disciplines. On every Dummy, students who studied that discipline were assigned the value 1 and all other students the value 0. To prevent over-determination of the model, Law students functioned as a reference group in the regression analyses.)

Beside the variables described above, the scales of the ILS were entered in the regression analyses. The regression analyses that were conducted all pertained to *linear* relations between independent and dependent variables. In all analyses the predictors were entered simultaneously, as total model. Beta weights were computed to establish the relation of an independent variable, or predictor, with a dependent variable, an ILS-scale, keeping the other predictors constant. These weights therefore represent relations that cannot be attributed to other predictors. Moreover, the proportions of variances in the dependent variables were computed that were explained by the total model of predictors. All Beta weights and percentages of explained variance were tested for significance by computing F values.

Question 2

Based on these data described above the following three academic performance variables were created: mean exam score, percentage of exams passed, and study pace. These three variables were all based on the same exams, and included all courses from the first semester study program. For the first two indicators only exams in which students participated were taken into account. The third indicator consisted of the percentage of courses from the first year study program of which students passed the exam successfully.

All analyses were conducted on the same group of students: only first year students with, as a minimum, one exam attempt. Only students who did the first year of their studies for the first time were included in the analyses. Pearson correlations were computed to analyse the relations among the three academic performance indicators and between the student learning variables and the performance indicators. These correlations were tested for significance two-tailed. Regression analyses were performed to determine the percentage of variance in exam results

explained by learning patterns as a whole. The percentages of explained variance were tested for significance by computing F values. All analyses were done both for the seven academic disciplines separately as well as over all academic disciplines cumulatively.

Results

Relations between student learning patterns and personal and contextual variables

In Table 1 the mean and standard deviation of the predictor 'age' is presented. In the same Table the frequencies and percentages of the other predictors are shown. In Table 3 the intercorrelations among the predictors are depicted.

Table 4 presents the results of the regression analyses: the proportion of variance explained in students' ILS-scores by the predictors age, gender, prior education and academic discipline, and the Beta weights regarding these variables.

Total model

The total model of predictors explains a significant part of the variance in 18 of the 20 ILS-scales. Of all ILS-scales, a certificate-directed

Table 3. Intercorrelations among the predictors age, gender, highest completed prior education and academic discipline (N = 792; correlations ≥ −0.05 and ≤ 0.05 omitted)[a]

Predictors	Age	Gender	Prior education
Age			
Gender			
Prior education	0.56***		
Academic discipline			
Law	0.09*		
Management Information science	−0.15***	−0.18***	−0.11**
Economy	−0.15***	−0.18***	−0.10**
Econometry	−0.25***	−0.15***	−0.20***
Sociology	0.27***	0.06	0.26***
Psychology	0.20***	0.26***	0.21***
Arts		0.20***	−0.10**

[a]*$p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed testing).

Table 4. Beta weights of age, gender, prior education and academic discipline as predictors of learning patterns based on the total regression model (N = 792), proportions of explained variance (R^2) by this model and significance levels of the F-values (weights ≥ −0.05 and ≤0.05 omitted)[a]

ILS scales	Predictors	Age	Gender	Prior education	Academic discipline						R^2 Total model	F (DF = 9,720)
					M.I.S.	Econo	Ecotry	Socio	Psycho	Arts		
Processing strategies												
Deep processing												
Relating and structuring		0.11*		0.09*	0.09*		−0.12*			0.06	0.08***	6.9
Critical processing		0.19***	−0.14***			−0.10*	−0.09	0.06	0.09	0.13**	0.12***	10.6
Stepwise processing												
Memorising and rehearsing		−0.06		−0.11*		−0.11*			−0.06	−0.06	0.04**	2.9
Analysing			−0.09*	−0.11**		−0.09		−0.11*	−0.19***	−0.15**	0.08***	7.1
Concrete processing		0.15***	−0.11**				−0.17***		0.11*		0.11***	9.7
Regulation strategies												
Self-regulation												
Learning process and results		0.10*	−0.06						0.15**		0.06***	4.7
Learning content		0.35***	−0.09*				−0.08				0.14***	12.5
External regulation												
Learning process				−0.11*	−0.06	−0.06	−0.06		−0.23***	−0.18***	0.05***	4.1
Learning results			0.14***	−0.07	0.16***	0.20***	0.22***		−0.14**	−0.15***	0.15***	14.2
Lack of regulation		0.16***		−0.15***	0.09*	0.10*	0.11*	0.06	0.08		0.03*	2.4

Table 4. Continued

Conceptions of learning										
Construction of knowledge	0.27***	0.08*		−0.08	−0.11*				0.14***	12.7
Intake of knowledge		0.06	−0.22***		0.09*	−0.07	−0.15**	−0.11*	0.13***	12.1
Use of knowledge					−0.11*	−0.09	−0.17**	−0.16***	0.04**	3.0
Stimulating education	0.07	0.07	−0.09	0.06	0.11*	0.07			0.02	1.7
Co-operative learning		0.18***	−0.09*	0.10*	0.14**	0.20***	0.09		0.07***	5.6
Learning orientations										
Personally interested	0.15***	0.07	−0.07	0.06		0.06	0.20***	0.18***	0.11***	9.4
Certificate-oriented	−0.15***	−0.15***	−0.07			−0.15**	−0.26***	−0.21***	0.21***	20.8
Self-test-oriented									0.01	0.6
Vocation-oriented		−0.07			−0.11*	−0.19***	−0.07	−0.20***	0.06***	5.5
Ambivalent		0.08*	−0.08	0.12*	0.19***	0.08			0.05***	3.8

F-value: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

M.I.S: Management Information Science; Econo: Economy; Ecotry: Econometry; Socio: Sociology; Psycho: Psychology. Law students function as reference group.

learning orientation, the external regulation strategy directed at monitoring and testing learning results, the learning conception 'construction of knowledge', the self-regulated strategy referring to regulating learning contents, and the learning conception 'intake of knowledge' are most associated with the whole of predictors, in the order of percentage of explained variance. None of these predictors contributes to variance in students' scores on the ILS-scales 'self-test directed learning orientation' and the learning conception 'stimulating education'. When we compare the contributions of the predictors age, gender, prior education and academic discipline to students' learning patterns, the following can be noticed.

Age

As was described in 'Introduction', research with the ILS among higher education students consistently shows that four learning patterns can be discerned: meaning directed, reproduction directed, application directed and undirected learning. Older students show more characteristics of meaning directed learning. They more often consult other sources than the prescribed syllabus, think that learning is equivalent to constructing own knowledge and insights, use both deep processing strategies, study out of personal interest, and use a self-regulation strategy directed at their learning process and results, than younger students. To the extent that students are older, they are also less certificate oriented in their learning orientation (one aspect of reproduction directed learning) and make more use of a concrete processing strategy in their studies (one aspect of application directed learning). The results do not show a relation between age and the value students attach to the use of the knowledge they acquire. With regard to undirected learning, it can be seen that that older students show more signs of lack of regulation than younger students. Summarizing, it can be stated that age is an important predictor of meaning directed learning. Age shows little associations with the other three learning patterns: reproduction directed, application directed and undirected learning.

Gender

The main difference between men and women is in their appreciation of cooperative learning: female students attach more value to cooperative learning than males. Furthermore, learning patterns do not seem to show consistent relationships with students' gender. Female students score higher than their male fellow students on an external regulation strategy, but lower on another aspect of reproduction

directed learning: a certificate orientation. Male students more often use a critical processing strategy, but on other aspects of meaning directed learning no differences show up. Male students also more often utilize a concrete processing strategy, but again, on other aspects of application directed learning there are no differences between the sexes. It must be concluded that, except for the value attached to cooperative learning, this study shows little to no consistent relationships between students' gender and their learning pattern.

Highest level of prior education

To the extent that their level of prior education is higher, students show less signs of reproduction directed learning. Students with only a secondary educational background make more use of memorising and detailed analytical strategies in processing the subject matter, use more external sources in regulating their learning processes, and are more of opinion that learning means taking in knowledge offered to them, than students whose level of prior education is higher. There are only a few relations between students' prior educational level and meaning directed learning. Prior education is not related to the use of self-regulation strategies or to constructive learning conceptions. Higher educated students use a relating and structuring strategy slightly more often. There are no associations with aspects of application directed learning. With regard to undirected learning, the results show that lower educated students show more characteristics of lack of regulation than higher educated students.

Thus, it can be concluded that the highest level of completed prior education mainly has to do with the degree to which students show reproduction directed learning. Prior education is an important predictor of this way of learning. Prior education is also an important predictor of the behavioural component of undirected learning: lack of regulation. Students' level of prior education is hardly related to the degree to which they show elements of meaning directed and application directed learning. Lastly, it is striking that there are no associations at all between students learning orientations and their level of prior education.

Academic discipline

Table 4 also shows whether there are differences in students' learning patterns associated with different academic disciplines. On a number of ILS-scales the seven academic disciplines seems to group into three: (1) students from Psychology, Arts and Sociology; (2) students from the

Faculty of Economics with as academic disciplines Economy, Econometry and Management Information Sciences; and (3) Law students.

Arts and Psychology students show most characteristics of meaning directed learning, Econometry and Economy students the least. Arts students belong to the highest scoring group on three aspects of this learning pattern: critical processing, the learning conception 'construction of knowledge', and a personal interested learning orientation. Psychology students also belong to the highest scoring students with regard to this learning conception and orientation, while they deviate as only group from other students because of a relative high score on self-regulation of their learning processes. Econometry students score lowest of all students on two aspects of this learning pattern: a 'relating' processing strategy and the learning conception 'construction of knowledge'. Economy students are least critical in their processing of subject matter. There are next to no differences between students from different academic disciplines in the degree to which they consult other sources than the prescribed syllabus in their studying.

Econometry and Law students show most characteristics of reproduction directed learning, Psychology and Arts students the least. Econometry students belong to the highest scoring group on the analytical processing strategy, external regulation of learning results, and the reproductive learning conception. Law students score relatively highly on an analytical processing strategy and on external regulation of learning processes. Students of Economy and Management Information Sciences belong to the highest scoring group on external regulation of learning results. Psychology and Arts students score the lowest on five aspects of this learning pattern: analytical processing strategy, both external regulation strategies, intake of knowledge as learning conception, and a certificate directed learning orientation. On this processing strategy and learning orientation, Sociology students also belong to the lowest scoring group. There are only small differences between students from the different academic disciplines in the degree to which they memorise and rehearse the subject matter.

Law students show most features of application directed learning, Arts students the least. With regard to the learning conception 'use of knowledge' and the vocational learning orientation Law students belong to the highest scoring group. Students of Management Information Sciences also score relatively highly on this learning orientation. Of all students, Psychology students study their subject matter most concretely, but they attach relatively little importance to the usability of the knowledge they acquire. Arts students belong to the lowest scoring

students on two aspects of application directed learning: the learning conception 'use of knowledge' and the vocational learning orientation. Sociology students belong to the lowest scoring students on one aspect of application directed learning: the vocational learning orientation. Students of Econometry process the subject matter least concretely of all students.

Students of Econometry and Economy show most characteristics of undirected learning, Law students least. The first mentioned students belong to the highest scoring group on three of the four aspects of this learning pattern: lack of regulation, cooperative learning, and an ambivalent learning orientation. Students of Management Information Sciences also have relatively high scores on the two first mentioned aspects. Arts students also score relatively low on cooperative learning and Psychology students on an ambivalent learning orientation. There are little differences between students from the different academic disciplines in the degree to which they value stimulating education.

With regard to the dominance of certain learning patterns in the various academic disciplines it can thus be concluded that meaning directed learning is found most among Psychology and Arts students and least among Econometry and Economy students. Reproduction directed learning is found most among Econometry and Law students and least among students from Psychology and Arts. Law students show most characteristics of application directed learning, Arts student the least. Finally, students of Econometry and Economy show most features of undirected learning, Law students the least. In summary, the results show that academic disciplines is an important predictor for all four learning patterns: application directed, meaning directed, reproduction directed, as well as undirected learning.

Relations between learning patterns and academic performance

In Table 5, the number of students in the different analyses is presented as well as the intercorrelations among the three indicators of academic performance. Because for most academic disciplines the intercorrelations among the different indicators are quite high, here only the relations between learning patterns and mean exam scores of students will be presented.

The intercorrelations between learning patterns and mean exam scores are displayed in Table 6. The relations between learning patterns and the other two indicators of academic performance, percentage of

Table 5. Numbers of students, and correlations between (1) mean exam score, (2) percentage of exams passed, and (3) study pace, for students of all 7 academic disciplines and per academic discipline[a]

Academic discipline	N	r_{1-2}	r_{1-3}	r_{2-3}
All 7 academic disciplines	569	0.86	0.75	0.85
Law	68	0.87	0.79	0.89
Management Information science	80	0.92	0.89	0.93
Economy	86	0.93	0.91	0.97
Econometry	68	0.86	0.74	0.89
Sociology	75	0.90	0.71	0.82
Psychology	132	0.70	0.49	0.62
Arts	60	0.85	0.51	0.65

[a]Significance level all correlations: $p < 0.001$ (two-tailed testing).

exams passed and study pace, are very similar. Learning patterns as a whole explain, over all academic disciplines, 25% of the variance in mean exam scores. For the separate academic disciplines this percentage varies between 28 for Psychology and 51 for Economy. When all academic disciplines are taken into consideration together, all six elements of meaning directed learning show significant positive relations with exam scores. There are, however, some subject-specific differences. The use of a relating and structuring processing strategy is associated with this indicator of academic performance only for Economy, Management Information Sciences (MIS), Sociology and Psychology, and the use of a critical processing strategy only for Econometry and Sociology. The more Econometry and Psychology students self-regulate their learning processes, the better they score on exams. Especially for Econometry and MIS, self-regulation in the sense of consulting sources outside the prescribed subject matter is associated with high exam scores. The personally interested learning orientation correlates significantly and positively for Sociology only.

Also various aspects of reproduction directed learning turn out to be related to mean exam score, although in this case almost exclusively negatively. Only for Econometry is the use of an analytical processing strategy positively associated with this indicator. Both external regulation strategies show negative, though weak, relationships when all academic disciplines are taken together in the analysis. The more students are of the opinion that studying mainly comes down to the intake of presented knowledge, the worse exam results they obtain in all academic disciplines and especially in Econometry, Law, Sociology and

Table 6. Correlations of learning patterns with mean exam score, over all 7 academic disciplines and per academic discipline, and proportions of explained variance (R^2) in mean exam score by learning patterns (correlations ≥ −0.05 and ≤ 0.05 omitted)[a]

ILS scales	Academic discipline[b]							
	All 7	M.I.S.	Econo	Ecotry	Law	Socio	Psycho	Arts
Processing strategies								
Deep processing								
Relating and structuring	0.25***	0.27*	0.07	0.30**		0.29**	0.27***	0.12
Critical processing	0.22***	0.11	0.13	0.28**	0.18	0.25*	0.10	
Stepwise processing								
Memorising and rehearsing			−0.10	−0.10	0.10		0.15	
Analysing		0.14	0.13	0.30**			0.08	0.17
Concrete processing	0.10*	0.19	−0.19	0.20			0.11	−0.09
Regulation strategies								
Self-regulation								
Learning process and results	0.15***	0.11	0.12	0.33**	0.06	0.06	0.18*	
Learning content	0.21***	0.29*	0.13	0.29**	0.09	0.19	0.13	0.13
External regulation								
Learning process	−0.09*	−0.12	−0.12	−0.17	−0.15	0.14		0.08
Learning results	−0.09*	0.07	0.15				0.07	
Lack of regulation	−0.32***	−0.34**	−0.36***	−0.29**	−0.44***	−0.22	−0.33***	−0.10
Conceptions of learning								
Construction of knowledge	0.13**	0.22	−0.12	0.11		0.12		0.08
Intake of knowledge	−0.26***	−0.17	−0.11	−0.31**	−0.24*	−0.22*	−0.19*	−0.10
Use of knowledge	−0.17***	−0.09	−0.13	−0.22*	−0.27*	−0.18		−0.24

Table 6. Continued

ILS scales	Academic discipline[b]							
	All 7	M.I.S.	Econo	Ecotry	Law	Socio	Psycho	Arts
Stimulating education	−0.14***	−0.14	0.07	−0.14	−0.33**	−0.16		−0.09
Co-operative learning	−0.25***		−0.12	−0.33**	−0.42***	−0.22'	−0.16	−0.10
Learning orientations								
Personally interested	0.21***	0.17	0.11	0.14		0.36**		0.22
Certificate-oriented	−0.23***	−0.12	−0.16	−0.19		−0.06	−0.08	−0.13
Self-test-oriented		0.13	−0.09		−0.07			−0.38**
Vocation-oriented	−0.09*		−0.20		−0.06	−0.09	0.06	−0.17
Ambivalent	−0.33***	−0.18	−0.35**	−0.28**	−0.25*	−0.38***	−0.36***	−0.31*
R^2	0.25***	0.35	0.51***	0.47***	0.48*	0.43*	0.28**	0.42
$DF=$	20,543	20,47	20,58	20,64	20,46	20,53	20,110	20,37
F	9.1	1.3	3.0	2.8	2.1	2.0	2.2	1.3

[a]Significance level: $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$ (correlations two-tailed testing).
[b]M.I.S: Management Information Science; Econo: Economy; Ecotry: Econometry; Socio: Sociology; Psycho: Psychology.

Psychology. A certificate orientation shows a negative relation with mean exam score over all academic disciplines, and a self-test orientation is negatively associated with this indicator for Art students.

Application directed learning shows rather inconsistent relations with mean exam scores. When all academic disciplines are taken together in the analysis, the use of a concrete processing strategy turns out to be associated in a positive way, while the learning conception in which the use of knowledge is stressed and the vocational learning orientation show negative relations with mean exam scores. Although within the different academic disciplines the correlations with the concrete processing strategy differ greatly, none of these reaches significant values. The learning conception in which the use of knowledge is stressed is negatively associated with mean exam scores especially for Law and Econometry.

The pattern of relations between mean exam score and elements of undirected learning is, however, highly consistent. In the analyses over all academic disciplines all aspects of this learning pattern show negative relations. Lack of regulation and an ambivalent learning orientation are negatively related to mean exam scores in all separate academic disciplines. The relations with the learning conceptions that belong to this pattern are, however, more subject specific in nature. Thus the degree to which students attach value to sharing the tasks of studying with fellow students is negatively associated with their exam scores mainly for Law, Econometry and Sociology, while the degree to which they think that education should continuously stimulate them correlates significantly and negatively only for Law students.

Conclusions and discussion

From the analyses reported above it can be concluded that students' learning patterns are indeed associated with personal and contextual factors, such as type of academic discipline, prior education, age and gender. All 20 aspects of learning patterns as operationalised in the present study were significantly related to one or more of these factors. Strikingly, the results seem to indicate that the different learning patterns have different sources. Thus, meaning directed learning is mostly associated with students' academic discipline and age. Reproduction directed learning proved to be most related to students' prior education and academic discipline. Application directed learning was most

associated with students' academic discipline, while undirected learning was associated to a comparable extent with various predictors.

Overall, of all predictors, academic discipline shows the strongest relations with students' learning patterns. These relations can be interpreted as effects of a subject domain, in the sense that different disciplines pose different demands on the way subject matter can best be studied. Thus, in this study the Social–Cultural disciplines would have demanded more meaning directed learning, while studying Economy and Law would have required more reproduction directed learning. Moreover, especially Law studies would have demanded application directed learning. Although this last finding can be explained by the high vocation-oriented nature of Law studies, Entwistle et al. (2003) model of student learning suggests that there are also differences in the teaching–learning environments among different academic disciplines. In this respect, Ramsden (1988) points to cultural differences in used teaching methods between disciplines. Therefore, the fact that reproduction directed learning was found more in some academic disciplines than in others may as well, or even more probably, reflect teaching and assessment characteristics than inherent properties of the academic discipline.

Another possible explanation for disciplinary differences in learning patterns among students is that these differences already existed before students started their studies, and led to different choices for academic disciplines (Kolb et al. 2001). Some studies may be more application-oriented in nature than others, and attract students whose learning patterns match. The finding that undirected learning has been found to be highest among students of the Faculty of Economics, can possibly be explained by the large number of first year students in this Faculty, in combination with mass lectures.

It was stated in the Introduction that although generally big differences are assumed to exist between younger and older people in their learning, these assumed differences are only to a small degree based on empirical evidence. In this study it was found that age was associated with meaning directed and undirected learning, both in a positive way. This simultaneous relationship seems contradictory at first sight. But it may well be that older students' inclination for meaning directed learning conflicted with the demand for reproductive learning imposed by the teaching–learning environment in at least some disciplines, resulting in students' confusion and lack of direction. This tension between inner inclinations and outer demands was also described by Lindblom-Ylänne and Lonka (2000) in a study on advanced medical

students. In this study, no empirical evidence was found for the often heard hypothesis that when people are older, they are more application directed in their learning. However, the age range was more limited than in some other studies, where application-directed learning did stand out as a clear dimension among advanced and adult students (e.g. Vermunt 1998; Lindblom-Ylänne and Lonka 2000)

Reproduction directed learning prevailed among students who came to university straight from secondary education. This may mean that students learned to learn in a reproductive way in this type of schooling. Since only students who were successful in secondary education, and graduated, were admitted to university studies, one must conclude that reproductive learning was adaptive in secondary education. The finding that the undirected learning pattern was also found more among students who came straight from secondary education, points to the fact that these students did have trouble with the demands of studying at university. Phenomena like these gave rise to a recent nation-wide educational innovation in secondary education in the Netherlands, aimed at a better preparation of pupils for university studies.

Few indications were found for typical male and female ways of learning. The biggest difference between the sexes was in female preference for, and male dislike of, cooperative learning. On the average, female students turned out to be more social and male students more individualistic in their way of learning.

Associations between learning patterns and personal and contextual factors may offer an explanation for the stability of learning strategies as found in earlier research (e.g. Vermunt 1998). The learning activities students employ are not only the result of instructional measures, but are apparently also embedded in a complex whole of personal and general contextual factors. These relations have implications for designing instruction. Since students' academic discipline, prior education, age and gender are either immediately visible or easy to find out, they form a first indication of what kind of learning will probably prevail in a certain group of students. This can be taken into account in an early phase of the instructional design process.

One of the main advantages of the regression model used in this study was that the association of various personal and contextual variables with learning patterns could be established more accurately than with straight one-to-one correlations. For example, age and prior educational level turned out to be highly intercorrelated, students from Psychology and Sociology were older and more often female than students from the Faculty of Economics, etc. This interrelatedness of

personal and contextual factors is fairly typical of university student populations. Thus, this regression model made it possible to confirm Marton and Säljö's (1997) hypothesis mentioned in the Introduction: it is not age but educational experience that is associated with reproductive conceptions of learning.

A second central issue addressed in this article was the extent to which exams that are common in the first year of higher education relate to the various learning activities that students employ. The results showed that students' learning patterns explained an important part of the variance in the exam results they attained: between 25% and 51%. Beside other predictors of exam performance, such as prior knowledge and time investment, students' learning patterns proved to be an important predictor. Second, there was a clear pattern of relations that, in general, pointed to the same direction. Third, and unfortunately, it must be concluded that some aspects of student learning, such as the use of critical, analytical and concrete thinking strategies, were rewarded in exam results only to a very limited extent.

Meaning directed learning was generally positively associated with different indicators of academic performance, in various types of subject domains. Reproduction directed learning mainly showed negative relations with exam performance. Application directed learning was rather neutral with respect to exam performance. Finally, undirected learning was negatively and consistently associated with academic performance, in all academic disciplines.

Relations between thinking strategies and learning performance turned out to vary in different academic disciplines. A striking fact is that in some disciplines relations between the use of processing strategies and indicators for academic performance were almost absent. In those disciplines it was apparently hardly relevant for exam results which thinking strategies students used to study subject matter. Only in a academic discipline like Econometry, an analysing strategy was positively associated with exam performance. This indicates that this discipline, possibly because Statistics plays an important role in it, capitalized on a thorough, analytic way of learning.

It is also striking that the way students regulated their learning processes, showed relative little direct relations with academic performance. Self-regulation strategies showed some positive relations. External regulation strategies showed few relations, but the associations they showed were almost exclusively negative. However, there were strong negative relations with an experienced lack of regulation. It seems that for exam achievements, it was less important whether

learning processes were regulated internally or externally, as long as they were regulated in some way. However, it can also be concluded that self-regulation strategies showed indirect positive relations with exam performance, especially via the activation of relating and structuring processing strategies. As earlier research has shown these processing strategies are hardly regulated externally but almost exclusively internally (Vermunt 1998).

In this study it was found that a learning conception in which much value is attached to sharing the tasks of studying with fellow students, was not related positively but negatively to exam performance. One explanation of this finding could be in terms of avoiders and engagers (Yan and Kember 2004). These researchers identified an avoider approach to group learning resulting from group collaboration on study tasks to minimize the amount of work each individual had to perform. Moreover, the traditional exams that prevailed in the present study called upon individual achievements and did not reward cooperative work.

Examinations as traditionally used in the beginning phase of higher education turn out to capitalize mainly on the use of relating and structuring processing strategies. The use of critical learning activities is far less rewarded in exam performance. This finding is consistent with statements of some students in earlier qualitative research, who stated that, according to their experience, critical processing did not contribute to better exam performance, and who therefore stopped using this strategy in their studies (e.g. Vermunt 1996). The degree to which students employed analytical, concrete and memorizing learning activities in processing the learning contents had, with a few exceptions, hardly anything to do with their exam performance. Contrary to an often heard view among students, memorising was not associated with high exam scores. The small association between the concrete processing strategy and exam performance points to the fact that the traditional exams in the first year of higher education hardly ever capitalise on the use of acquired knowledge to solve problems.

As with any study, this study also has limitations. One is that study processes in the students' current context were correlated with learning outcomes in previous, although similar, contexts. Another limitation is that the university at which the study was conducted does not offer Natural or Technical sciences, so these disciplines could not be included in the study. The teaching and assessment methods were rather traditional in nature, so it is possible that other results will be obtained when more innovative teaching methods (e.g. problem-based learning,

project-centred learning) or assessment methods (e.g. portfolio) are included. To overcome these limitations in future studies, attempts should be made to also correlate students' study processes in current contexts with learning outcomes in simultaneous, or future, contexts. Moreover, also Natural, Technical and Medical studies should be included, as well as more innovative teaching and assessment methods.

References

Busato, V.V., Prins, F.J., Elshout, J.J. and Hamaker, C. (1998). 'Learning styles: A cross-sectional and longitudinal study in higher education', *British Journal of Educational Psychology* 68, 427–441.

Busato, V.V., Prins, F.J., Elshout, J.J. and Hamaker, C. (1999). 'The relation between learning styles, the Big Five personality traits and achievement motivation in higher education', *Personality and Individual Differences* 26, 129–140.

Boyle, A.B., Duffy, T. and Dunleavy, K. (2003). 'Learning styles and academic outcome: the validity and utility of Vermunt's Inventory of Learning Styles in a British higher education setting', *British Journal of Educational Psychology* 73, 263–290.

Cunningham, D.J. (1991). 'Assessing constructions and constructing assessments: a dialogue.' *Educational Technology* 31(5), 13–17.

De Jong, F.P.C.M. (1995). 'Process-oriented instruction: Some considerations', *European Journal of Psychology of Education* 4, 317–323.

Entwistle, N. and McCune, V. (2004). 'The conceptual bases of study strategy inventories', *Educational Psychology Review* 16(4), 325–345.

Entwistle, N. (2000, December). *Some aspects of the teaching–learning environment influencing approaches to studying*. Paper presented at the first meeting of the Edinburgh-2000 Group, Edinburgh, UK.

Entwistle, N., McCune, V. and Hounsell, J. (2003). 'Investigating ways of enhancing university teaching–learning environments: Measuring students' approaches to studying and perceptions of teaching', in de Corte, E., Verschaffel, L., Entwistle, N. and van Merriënboer, J. (eds.), *Powerful Learning Environments: Unravelling Basic Components and Dimensions,* Oxford: Pergamon, pp. 89–107.

Entwistle, N., McCune, V. and Walker, P. (2001). 'Conceptions, styles and approaches within higher education: analytical abstractions and everyday experience', in Sternberg, R.J. and Zhang, L.F. (eds.), *Perspectives on thinking, learning and cognitive styles*. Mahwah, NJ: Erlbaum, pp. 103–136.

Geisler-Brenstein, E., Schmeck, R.R and Hetherington, J. (1996). 'An individual difference perspective on student diversity', *Higher Education* 31, 73–96.

Kolb, D., Boyatzis, R.E., and Mainemelis, C. (2001). 'Experiential learning theory: previous research and new directions', in Sternberg, R.J. and Zhang L.F. (eds.), *Perspectives on thinking, learning and cognitive styles*. Mahwah, NJ: Erlbaum, pp. 227–247.

Lindblom-Ylänne, S. and Lonka, K. (1999). 'Individual ways of interacting with the learning environment – Are they related to study success?', *Learning and Instruction* 9, 1–18.

Lindblom-Ylänne, S. and Lonka, K. (2000). 'Dissonant study orchestrations of high-achieving university students', *European Journal of Psychology of Education* 15, 19–32.

Lonka, K., Heikkilä, A., Lindblom-Ylänne, S. and Maury, S. (1997, August). *Are epistemologies related to study activities in an innovative course?* Paper presented at the 7th Conference of the European Association for Research on Leaning and Instruction, Athens, Greece.

Lonka, K., Olkinuora, E. and Mäkinen, J. (2004). 'Aspects and prospects of measuring studying and learning in higher education', *Educational Psychology Review* 16(4), 301–323.

Marton, F. and Säljö, R (1997). 'Approaches to learning', in Marton, F., Hounsell, D. and Entwistle, N. (eds.), *The Experience of Learning* (2nd edition). Edinburgh: Scottish Academic Press, pp. 39–58.

Meyer, J.H.F. (2000). 'The modeling of 'dissonant' study orchestration in higher education', *European Journal of Psychology of Education* 15, 5–18.

Meyer, J.H.F., Parsons, P. and Dunne, T.T. (1990). 'Individual study orchestrations and their association with learning outcomes', *Higher Education* 20, 67–89.

Ramsden, P. (1988). 'Context and strategy: situational influences on learning', in Schmeck, R.R., (ed.), *Learning strategies and learning styles*. New York: Plenum Press, pp. 159–184.

Richardson, J.T.E. (2000). *Researching student learning*. Buckingham: SRHE and Open University Press.

Richardson, J.T.E., Morgan, A. and Woodley, A. (1999). 'Approaches to studying in distance education', *Higher Education* 37, 23–55.

Rozendaal, J.S., De Brabander, C.J. and Minnaert, A. (2001, August). *Boundaries and dimensionality of epistemological beliefs*. Paper presented at the 9th Conference of the European Association for Research on Leaning and Instruction, Fribourg, Switzerland.

Severiens, S.E. and Ten Dam, G.T.M. (1997). 'Gender and gender identity differences in learning styles', *Educational Psychology* 17, 79–93.

Trigwell, K. and Prosser, M. (1991). 'Relating approaches to study and quality of learning outcomes at the course level', *British Journal of Educational Psychology* 61, 265–275.

Trigwell, K., Prosser, M. and Waterhouse, F. (1999). 'Relations between teachers' approaches to teaching and students' approaches to learning', *Higher Education* 37, 57–70.

VanderStoep, S.W., Pintrich, P. and Fagerlin, A. (1996). 'Disciplinary differences in self-regulated learning in college students', *Contemporary Educational Psychology* 21, 345–362.

Vermetten, Y.J., Lodewijks, H.G. and Vermunt, J.D. (2001). 'The role of personality traits and goal orientations in strategy use', *Contemporary Educational Psychology* 26, 149–170.

Vermunt, J.D. (1996). 'Metacognitive, cognitive and affective aspects of learning styles and strategies: A phenomenographic analysis', *Higher Education* 31, 25–50.

Vermunt, J.D. (1998). 'The regulation of constructive learning processes', *British Journal of Educational Psychology* 68, 149–171.

Vermunt, J.D. (2003). 'The power of learning environments and the quality of student learning. in de Corte', E., Verschaffel, L., Entwistle, N. and van Merriënboer,

J. (eds.), *Powerful Learning Environments: Unravelling Basic Components and Dimensions,* Oxford: Pergamon, pp. 107–122.

Vermunt, J.D. and Verloop, N. (1999). 'Congruence and friction between learning and teaching', *Learning and Instruction* 9, 257–280.

Yan, L. and Kember, D. (2004). 'Avoider and engager approaches by out-of-class groups: the group equivalent to individual learning approaches', *Learning and Instruction* 14, 27–49.

Zeegers, P. (2001). 'Approaches to learning in science: A longitudinal study', *British Journal of Educational Psychology* 71, 115–132.