The extent of variability in learning strategies and students' perceptions of the learning environment

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Abstract

The variability in deep and surface learning has been discussed as part of the trait vs. state debate. However, the question is to what extent students change strategies as a function of course demands. This study focused on discerning subgroups of learners with respect to variability in learning strategies and the role of students' learning environment perceptions in it. Data from 124 second-year university students in three consecutive courses were collected. Cluster analysis on the variability of learning strategies revealed two groups of students: a restricted one and a variable one. Differences in variability of learning between the restricted and variable clusters can be explained by the impact of learning environment perceptions on learning strategies and by the variation in the perceptions of the learning environment factors.
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1. Introduction

Since Marton and Säljö (1976) identified deep and surface approaches to learning, a lot of attempts have been made to influence students' levels of deep and surface learning. Marton and Säljö (1976) assumed that learning approaches are not stable psychological traits and that students adjust their approaches to learning, depending on the requirements of the task. Although, as Biggs (1993) suggests, students might have a predisposition to either deep or surface learning approaches in general, research has indeed shown that this preferred approach can be modified by the learning environment for individual courses or for particular tasks (Ramsden, 1984). Many researchers have indicated that it is not the learning environment as such that influences the students' learning approaches, but it is students' perceptions of the learning environment that have these effects (e.g., Ramsden, 1988; Sadlo & Richardson, 2003; Trigwell & Prosser, 1991). In this respect, research has established several key elements of the perceived learning environment, such as, the quality of the teaching staff, the clarity of the goals and what is expected from the students, the kind of assessment,

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the workload, and the degree of choice students have in their learning (Lizzio, Wilson, & Simons, 2002; Wilson, Lizzio, & Ramsden, 1997). Nijhuis, Segers, and Gijselaers (2005) showed the relationship between learning strategies and the perceptions of the learning environment in a Problem-Based curriculum. They found that changes in the format of a course resulted in differences in students' learning strategies in relation to differences in students' perceptions of the learning environment. More specifically, the study showed significant differences in the students' perceptions of the clarity of the goals, the extent of independent learning and the appropriateness of the workload.

However, some studies (Gibbs, 1992; McParland, Noble, & Livingston, 2004; Vermetten, Vermunt, & Lodewijks, 2002) showed that there are limitations to the variability of learning approaches. A case in point is a study by Trigwell, Hazel, and Prosser (1996), who described a dissonant group of students whose learning was not influenced by the learning environment. They concluded that "It suggests (as may be expected) that many students see no particular influence of the environment on their approach to learning, and hence no influence on the quality of their learning." (Trigwell et al., 1996: 4). This finding would suggest that some students, or at least some groups of students, have rather stable learning approaches. Vermetten, Lodewijks, and Vermunt (1999) support this notion and propose more research concentrating on differences between subgroups concerning variability in learning strategies. "Some students might be quite fixed in the use of learning strategies, whereas others might be quite flexible or versatile strategy users" (Vermetten et al., 1999: 17). As such, the stability vs. variability of learning approach question fits the "trait vs. state" debate (Watkins, 2001). However, the question is to what extent students can be classified into the dichotomy "stable vs. variable". Human behaviour covers a broader range than just two categories. The question can also be refined by focussing on groups of students with different levels of variability (e.g., low, medium and high). This leads to two interesting research questions. First, can subgroups of learners be discerned with respect to variability in learning strategies? Second, if so, taking into account the influence of students' perceptions of the learning environment on their learning strategies, to what extent do these subgroups differ in their perceptions of the learning environment? This study addressed both questions.

1.1. Variability in learning strategies

Students' learning has been researched using a variety of constructs (e.g., instructional preferences, learning style, and cognitive style), which can be conceptualized like the layers of an onion (Curry, 2002). She places learning strategies at the outer layer of the onion, implying that they are most influenced by the environment. This means that learning strategies are most adaptable to change, compared to other constructs. Learning strategies have been extensively researched in many other studies using the definition of Biggs (1987). He describes a learning strategy as how a student engages in a task and in this respect defines it as actual behaviour in a specific context. Other researchers stress the stability of learning strategies by using Vermunt's (1998) definition of a learning strategy: regularly used combinations of learning activities. Two leading research designs can be identified with studies addressing the variability in learning strategies: between-students and within-students designs. The between-students research design focuses on comparisons between different groups of students in different learning environments (e.g., Nijhuis et al., 2005; Vermetten et al., 2002). In these studies, the impact of a course re-design on learning strategies is analyzed. In the within-students research design, researchers investigate the same group of students in different learning environments (e.g., Eley, 1992; Fazey & Lawson, 2001; Jones, 2002; Wilson & Fowler, 2005).

With respect to the between-students design, the study by Vermetten et al. (2002) is a case in point. They researched the effect of an educational reform project aimed at improving teaching-learning processes. It was assumed that by changing the learning environment, students would adjust their learning strategies. Differences in deep learning (in terms of relating, structuring, and critical processing) and in surface learning (in terms of memorizing and analyzing) were analyzed in nine different courses. As regards deep learning, two observations were made: first, relating and structuring increased significantly in one course; second, critical processing increased significantly in two courses. There was no significant difference between courses with respect to surface learning. They concluded that the reforms hardly had any impact on learning strategies. This finding may indicate the stability of learning strategies: that is, learners demonstrate stable learning strategies across different learning environments. Another explanation could be that the changes in the learning environment were not strong enough to induce changes in learning strategies. However, a study by Nijhuis et al. (2005) showed variability in learning strategies when comparing students' learning in two different formats of the same course. The course was redesigned, from a fairly well-structured format using clear-cut questions to guide students' learning, to a Problem-Based format using unstructured problems. The results showed

that students in the redesigned environment had lower levels of deep learning and higher levels of surface learning compared to students in the original format. These findings indicate that the learning environment can have an impact on students' learning, thus increasing variability in learning strategies. Additionally, it was shown that changes in learning strategies could be explained by differences in students' perceptions of the learning environment.

In summary, studies comparing students in different learning environments report both stability and variability in learning strategies. However, these studies compared strategies of learning between different groups of students and, therefore, no conclusions can be formed on the variability in learning within individual students.

With respect to studies using a within-students research design, interesting, although different, insights are offered. For example, Eley (1992) researched the variability in learning strategies in a sample of about 150 second-year university students in four pairs of concurrent course units. Students' learning strategies and perceptions of the learning environment were analyzed across courses and within students. He concluded that there were some, although minor, differences in learning strategies within each pair of course units. Furthermore, differences in the perceptions of the learning environment were related to differences in learning strategies. Strangely, however, this pattern was not consistent for all students. In another study, Fazey and Lawson (2001) compared the learning strategies of a cohort of first-year students in two sequential courses: a traditional design and a design aimed at deep learning. There were no significant differences between the courses for either deep or surface learning. This indicated stability of learning strategies. By contrast, a study by Vermetten et al. (1999) revealed both stability and variability in learning strategies. They studied two cohorts of first-year Law students during courses of the Law Department in order to measure students' cognitive processing strategies. Memorizing (as part of a surface learning strategy) was the most stable over the courses. More variation was shown for relating and structuring (as part of a deep learning strategy).

Both Jones (2002) and Wilson and Fowler (2005) used within-students designs but extended their analysis by comparing two groups of students: deep and surface learners. The research setting included two concurrent courses (one traditional course assumed to foster surface learning and one course promoting deep learning). Students were classified as deep or surface learners, based on a base-line measurement in the first week of the semester. Subsequently, in the last week, learning approaches in both courses were measured again. Jones (2002) reports that surface learners increased their deep strategy significantly more than the deep learners. Wilson and Fowler (2005) found that students in the typical deep learning group reported no significant differences in either deep or surface scales or on motive or strategy scales across the two courses. Students in the typical surface learning group only reported a greater use of deep strategy in the revised course. These studies indicate that subgroups, based on their habitual learning approaches, show different degree of variability in learning. However, the groups were defined by the ratio of deep to surface learning, leaving open the question of how to group students on the basis of variability in learning approaches.

To summarize, studies indicate that students show stability and variability in their learning strategies. The question can be raised as to whether this contradictory picture in learning strategies is related to students' perceptions of the learning environment. In other words, can perceptions of the learning environment predict the variability of students' learning strategies? This was the central question of this study.

2. Context

Measuring variability in students' learning requires a research setting that allows the study of the same students in different contexts. These contexts should differ in such a way that they induce different levels of deep and surface learning. A suitable sample was found in the second year of the International Business Programme in a university that uses Problem-Based Learning (PBL) as its main educational approach.

The general idea in PBL, as initially developed by Barrows and Tamblyn (1980), typically involves students working on problems in small groups of five to 12, with the assistance of a tutor. The tutor coaches the group by monitoring the group process and helping the students to identify the knowledge they need to resolve the problem. The basic idea in all courses is that students work in groups, take great responsibility for regulating their own learning, and set their own learning goals (Gijselaers, 1996; Moust, Bouhuijs, & Schmidt, 2001). A course lasts 7 weeks, with two sessions per week. After Week 7 there is a separate week for testing. In the first session problems are analyzed, resulting in the formulation of learning goals, which guide the study of literature at home. In the next session, based on the theoretical framework resulting from the literature study, the problems are analyzed in depth, solutions are discussed and the relevance of the theoretical framework for novel problems is argued. The planned workload for the course is about

20 h per week. Parallel to the course, students have to attend a skills training course, which has a workload of another 20 h. By the second year, students have become very well acquainted with PBL, as they will have all successfully completed the first year (which is selective in nature) in which PBL also served as the main educational format.

In this study, the second-year students were followed for three consecutive courses which were part of the compulsory second-year programme. The three courses were International Business Strategy, International Finance & Accounting, and International Marketing. These courses are a continuation of introductory business courses in the first year. The sample chosen is suitable for three reasons. First, because of the compulsory character of the courses, the number of dropouts is limited. Second, the sample includes the Finance & Accounting course. This is a subject that is characterized by relatively high surface learning and relatively low deep learning (Booth, Luckett, & Mladenovic, 1999; Eley, 1992). Third, although PBL is the general approach of the faculty, individual course coordinators can make modifications to the course format, so that the courses differ in their specific learning environment design elements. Therefore, based on the results of previous research, the expectation is that the courses induce different learning strategies.

To get an insight into students' learning environments, the course books were analyzed. This enabled the focus to be fixed on aspects that could make a difference as described by Nijhuis et al. (2005), namely, the clarity of the goals, the workload, and the freedom in learning. The second year starts with the International Business Strategy course which covers various topics, such as analysis of economic regions, selection of countries in which to do business, and selection of the entry mode (e.g., export or direct investment). The problems in the course are rather well-defined specific questions and literature references are given to the students. The expectation is that students perceive the *goals of this course as being clear*. The compulsory literature consists of one introductory textbook so that, together with the well-defined nature of the problems, this should result in a *positive perception of the workload*. Each session is chaired by two students, who also prepare a short presentation in which they report on the findings of their literature study. During the course, each of the students selects a company from a set of companies to visit. Subsequently, three to four students, working as a group, write a comparison of their findings. Both the presentation and the company visit give students *some freedom in learning*.

The second course is International Finance & Accounting. This course deals with topics such as relationships between international financial markets and exchange rates, valuation and consolidation of international investments, and international differences in financial statement analysis. The problems draw upon authentic financial data from companies that operate internationally. Tutorial groups have to derive their own learning objectives from the problems and no references are given to students for the problem. Although the number of chapters that students have to cover by the end of the course is specified, the expectation is that they will perceive the *goals as being fairly vague*. The literature involves parts of four textbooks and several articles, probably inducing a *higher workload* for the students. Given the format of the problems and the lack of presentations or papers, there is *less choice in learning* for the students.

Finally, the International Marketing course deals with marketing problems encountered when companies operate in international markets. Two parallel paths can be discerned in the course, which are reflected in the ''problems in a meeting''. The first problem in a session focuses on marketing theory and deals with issues such as globalization of the market, standardization vs. adaptation, market segmentation and international product management. The problem contains a short description of a situation, linked to a case study, which has to be read before the meeting. The literature for this part of the course is a reader with a number of articles; the sequence of the articles runs in parallel with the sequence of the respective problems. The second problem in each session deals with market research and describes in brief a particular phase of the market research process. The title of the task each time is directly related to the relevant chapter of the accompanying compulsory textbook. In view of the format of the problems and the structure of the course, the expectation is that students will know what they have to do, and therefore have a *fairly clear idea about the goals*. Groups of three to four students have to carry out market research, based on their class-based discussions of the market research process. The research topic is fixed, but students are free in how they interpret the research. So, the market research component gives students a *choice in their learning*. Given the literature to be studied, the market research, the related calculations and the written report, the expectation is that students perceive the *workload as high*.

To conclude, it can be anticipated that students will show variability in the perceptions of the three learning environments, with respect to the clarity of goals, the degree of freedom in learning, and the workload as summarized in Table 1.

Table 1
Expected students' perceptions of the learning environment in the three courses

Perception	International business strategy	International finance & accounting	International marketing
Clarity of goals	Clear	Vague	Clear
Workload	Appropriate	High	High
Independent learning	Some	Little	Some

3. Aims – hypotheses

Many educators try to enhance students' level of deep learning by designing appropriate learning environments. To date, the results of studies on variability in students' learning strategies are inconclusive and empirical studies on the role of the perceptions of learning environment in the variability of learning strategies are scarce. This study aimed at investigating the degree of variability in learning strategies across three courses that differed in their learning environment, depending on how the learning environment is perceived.

Given the current status of theory it is not possible to formulate a classical hypothesis which can be tested. However, the available research on students' learning allows one to formulate some expectations in the form of working hypotheses.

As previously stated, although PBL is the general educational approach for the three courses being examined, differences exist with respect to the implementation of the approach. The expectation is that these differences in the implementation of PBL will result in differences in students' perceptions of the learning environment. Based on the outcome of a previous study on learning strategies and perceptions of the learning environment in a PBL context (Nijhuis et al., 2005), the expectation is that differences in the design of a PBL environment will be associated with different perceptions of the clarity of the goals, the extent of independent learning, and the appropriateness of the workload. Additionally, our previous study (Nijhuis et al., 2005) indicated that students' perceptions of the quality of the teaching and of the appropriateness of the classroom assessment did not significantly differ between the learning environments compared. This leads to the following working hypothesis: There will be variability in the perception of the learning environment across the different courses. More specifically, we expected that students' perceptions of clarity of goals, the extent of independent learning, and the workload will differ across the courses, while students' perception of the quality of teaching and the appropriateness of the assessment will not differ (Hypothesis 1).

To the extent the perceptions of the clarity of goals, the degree of independent learning and the workload vary over the three courses, and given the relations between these perceptions and learning strategies (e.g., Sadlo & Richardson, 2003; Trigwell & Prosser, 1991), it can be expected that there will be variability in learning strategies across the different courses (Hypothesis 2).

However, Trigwell et al. (1996) indicated that some students might not be influenced by the learning environment. Moreover, Vermetten et al. (1999) suggested that there seem to be differences in variability. Therefore, the expectation is that there will be different groups of students with respect to the variability in learning strategies in the three courses (Hypothesis 3).

Given the evidence that the adaptation of learning strategies by students is related to their perception of the learning environment (e.g., Sadlo & Richardson, 2003; Trigwell & Prosser, 1991) and based on the hypothesis that clusters with differences in variability in learning strategies can be discerned, a fourth working hypothesis was formulated: Clusters of students differing in their variability of learning strategies will differ in the variability of their perceptions of the learning environment (Hypothesis 4).

Finally, Trigwell et al. (1996) suggested that some students might not be influenced by the learning environment. Furthermore, Vermetten et al. (2002) suggested that students use aspects of the learning environment in different ways. This means that, for some students, there is no influence of the instructional process on their learning processes. Therefore, although students' learning strategies are normally influenced by their perceptions of the learning environment, the impact of the perceptions of the learning environment might differ between groups of students. As a result, changes in the perceptions of the learning environment will not always result in changes in students' learning strategies, indicating stability of learning strategies. Consequently, our last working hypothesis was: Clusters of students differing in their variability in learning strategies will differ in the effect of the perceptions of the learning environment on their learning strategies (Hypothesis 5).

4. Method

4.1. Sample

From the 372 students starting the programme, respectively, 317, 210 and 201 students returned the questionnaires in the successive courses. Useable data was available from more than 90% of the students who attended a course's final session. However, only cases with complete data sets were used, resulting in 124 cases. Students' age was in the range of 19–22 years; the breakdown by gender was 56% male and 44% female. Nationalities were as follows: 70% Dutch, 12% German, and 18% other, mainly European. The official language of the International Business Programme is English, so all second-year students are familiar with the language.

Because of its design, the study depended upon students' attendance during the session in which the questionnaires were administered. In one particular course, not all tutorial groups were available. Furthermore, students did not always show up during the final session. In the present study, the sample consisted of students who attended all three final sessions. These students formed a select group, differing from students who attended only one or two final sessions, the so-called non-response group. For each course, therefore, the learning strategies of the non-response group of students were compared with the learning strategies of the select group. There were no significant differences in the learning strategies between the two groups. Accordingly, it was assumed that the sample was representative of the whole population.

4.2. Instruments

4.2.1. Learning strategies

Students' learning strategies were measured with the Study Process Questionnaire (SPQ; Biggs, 1987). This instrument assesses surface and deep learning approaches. Each approach has two components: students' motives and their learning strategies. The motive component relates to the reasons why students engage in learning. The strategy component refers to how the task is processed and is a reference to students' learning activities. In the present study we focused on learning strategies and therefore left out the motive subscale. Both surface and deep strategy are represented with seven items. One item of the surface strategy subscale was removed because it didn't fit into the PBL setting. Thus, deep learning was represented with seven items and the surface learning with six items. Example items are: "I learn some things by rote, going over and over them until I know them by heart" and "I try to relate what I have learned in one subject to that in another" for surface strategy subscale and deep strategy subscale, respectively. Responses were on a five-point scale ranging from 1 = disagree to 5 = agree. In the present study, the Cronbach's alpha coefficients in the three testing sessions ranged between 0.62 and 0.70 for deep strategy and between 0.40 and 0.60 for surface strategy. These coefficients are in line with other studies as described by Watkins (1998).

4.2.2. Perceptions of the learning environment

Students' perceptions of the learning environment were measured with the Course Experiences Questionnaire (CEQ), originally developed by Ramsden (1991). Wilson et al. (1997) described three versions of this questionnaire (CEQ36, CEQ30, CEQ23) differing in the number of scales (five to six) and the number of items per scale. The basis for the questionnaire in the present study is the short version (CEQ23). Items of the scale for generic skills (e.g., this course has sharpened my analytical skills) were omitted as these are outcomes of the learning process, rather than inputs for the learning strategy. Items from the CEQ30, belonging to the scale for independent learning, were included in the questionnaire because of their relationship to learning strategies and their role in PBL. These adjustments resulted in five indicators (scales): good teaching (e.g., The teaching staff of this course motivate students to do their best work), clear goals (e.g., It is always easy here to know the standard of work expected), appropriate assessment (e.g., Too many staff ask us questions just about facts (reversed coding needed)), appropriate workload (e.g., The workload is too heavy (reversed coding needed)), and independent learning (e.g., Students here are given a lot of choice in the work they have to do). The responses were on a five-point scale ranging from 1 = disagree to 5 = agree. In the present study Cronbach's alpha coefficients for the respective indicators in the three courses ranged for good teaching (five items) from 0.82 to 0.87, for clear goals (four items) from 0.60 to 0.69, for appropriate assessment (three items) from 0.50 to 0.64, for appropriate workload (four items) from 0.72 to 0.75, for independent learning (six items) from 0.44 to 0.69.

As English is the official language of the International Business Programme and second-year students are familiar with it, the English versions of SPQ and CEQ were used.

4.3. Procedure

Both the SPQ and the CEQ were administered in the final session of each course, when extra time was available and students did not need to free up study time to complete the questionnaires.

4.4. Method of analysis

To analyse the differences in learning strategies and perceptions of the learning environment across courses ANOVA with repeated measures was used. As Mauchly's test of sphericity was not met, the Greenhouse−Geisser test was used (Tabachnick & Fidell, 2001). As an effect size, the partial eta squared was used. In addition, regression analysis was used to determine relationships between learning strategies in different courses and the perceptions of the learning environments. To measure variability the standard deviation for both deep and surface learning over the three courses was calculated.

To identify subgroups of students on the basis of the variability in both deep and surface learning, cluster analysis was used. Cluster analysis forms groups of individual objects into clusters using a set of variables (Hair, Anderson, Tatham, & Black, 1998). Two categories of cluster analysis can be identified: hierarchical and non-hierarchical, each having its own qualities. Following Hair et al. (1998), for the purposes of the present study, a combination of the hierarchical (for determining the number of clusters) and non-hierarchical method (for fine-tuning) was used. In order to estimate the number of clusters, the hierarchical procedure, ''Ward's method'', was used. This method aims to define clusters with about the same number of observations in each (Hair et al., 1998). Furthermore, it performs best at structure recovery in data where outliers are present. Subsequently, the number of clusters and the centroids of the clusters provided by the hierarchical cluster analysis were used in a *K*-means analysis for the fine-tuning of the solution.

One of the problems in empirical research is the detection of outliers. In cluster analysis this problem arises at two stages (Hair et al., 1998). First, just as in other research methods, the researcher can look for extreme values before the analysis takes place. However, as variables are treated separately, no overall view can be distinguished. Several outliers together could still make a separate cluster. The second stage is after the analysis has been performed. An indication of an outlier is the cluster size. Widely varying or very small cluster sizes are reasons for further examination.

Subsequently, a mixed linear model (Twisk, 2003), allowing for multiple observations from the same student, was used to identify relationships between students' perceptions of the learning environment and their learning strategies. This model is an extension of regression and ANOVA that allows the researcher to model the within-subject dependence and get a picture of the subject-level pattern of change, not just the population average pattern of change. Additionally, mixed linear models allow each subject to have its own time points of observations with any pattern of missing data. The mixed linear model assumes two effects, a random effect and a fixed effect. For the purposes of the present study, there is a random student effect and a fixed effect of the learning environment. All tools used in this study are available in SPSS, version 12.0.1.

5. Results

5.1. Variability in perceptions of the learning environment across the different courses

As there were five variables describing the perceptions of the learning environment in the three consecutive courses, a one-way MANOVA with repeated measures was used. The analysis showed a very significant course effect, Wilks' Lamda $= 0.42$, $F(10, 460) = 25.21$, $p < 0.001$, η^2 (Partial eta squared) $= 0.35$. Students perceived several aspects of the learning environment significantly differently (see Table 2). There was an effect of the course on clear goals, $F(2, 234) = 9.92$, $p < 0.001$, $\eta^2 = 0.08$. The effect was caused by the International Business Strategy course. The post hoc analysis (Bonferroni) revealed that the score in this course was higher than in the other two courses ($p < 0.01$).

Table 2
Mean (and standard deviation) scores of students' perceptions of learning environments in the three courses ($N = 124$)

Perception	Number of items	International business strategy	International finance & accounting	International marketing
Good teaching	5	16.31 (3.52)	15.94 (3.92)	16.71 (3.82)
Clear goals	4	14.11 (2.61)	12.88 (2.50)	13.22 (2.48)
Appropriate assessment	3	10.48 (1.99)	10.86 (2.23)	10.64 (1.88)
Appropriate workload	4	14.29 (2.62)	10.08 (3.14)	9.58 (2.88)
Independent learning	6	16.79 (3.04)	15.40 (2.78)	16.65 (3.12)

There was an effect of the course on appropriate workload, $F(2, 234) = 136.8$, $p < 0.001$, $\eta^2 = 0.54$. Students considered the workload in the International Business Strategy course as significantly more appropriate than in the International Finance & Accounting and in the International Marketing courses ($p < 0.01$).

Finally, independent learning also differed across the courses, $F(2, 234) = 12.58$, $p < 0.001$, $\eta^2 = 0.10$. A pair-wise comparison showed that the International Finance & Accounting course differed from the others, $p < 0.01$. It was perceived as offering fewer opportunities for independent learning. As regards good teaching and appropriate assessment, the mean scores did not significantly differ across the three courses.

5.2. Variability in learning strategies across the different courses

The effect of the course (independent variable) on both deep and surface learning strategies (dependent variables) was explored by means of a one-way MANOVA with repeated measures. There was a significant effect of the course, Wilks' Lamda = 0.65, $F(4, 490) = 29.30$, $p < 0.001$, $\eta^2 = 0.19$.

For deep learning, the main effect of the course was significant, $F(2, 246) = 36.3$, $p < 0.001$, $\eta^2 = 0.23$. Post hoc pair-wise comparison of means (Bonferroni) revealed that scores for deep learning strategies differed significantly across all the three courses, $p < 0.05$. Also, for surface learning there was a main effect of the course, $F(2, 246) = 27.65$, $\eta^2 = 0.18$. Post hoc pair-wise comparisons of means revealed that the level of surface learning strategies differed statistically across all the three courses, $p < 0.05$ (see Table 3).

5.3. Subgroups of students on the basis of variability in learning strategies

To measure variability in learning strategies, the standard deviation of the deep and the surface learning strategies over the three courses was calculated. This resulted in the following means (and standard deviations) of variability: for deep learning, $M = 2.86$ (SD = 1.8), for surface learning, $M = 2.2$ (SD = 1.3). As these measures of variability were in the same range, we did not use standardized values. In Fig. 1 a scatter diagram shows the position of the cases with respect to the variability in both deep and surface learning strategies. As can be seen in Fig. 1, a few cases could be classified as outliers. However, due to the exploratory nature of the study, these cases were still included in the cluster analysis.

The hierarchical clustering analysis (Ward, Euclidean distance) revealed the following agglomeration figures for the successive numbers of clusters: (4) 201, (3) 260, (2) 382 and (1) 616. The sudden increase from two clusters to one cluster indicates that a two-cluster solution might be appropriate for the sample. In this case, the cluster sizes were 51 and 73. To get a deeper insight in the final number of clusters, a three-cluster solution was also examined. In this case, the cluster sizes are 46, 5, and 73. The smallest cluster contained all the elements with a standard deviation for deep learning of more than 7 (see Fig. 1). This analysis showed that cases, which might initially be classified as outliers,

Table 3
Mean (and standard deviation) scores of students' learning strategies for different business courses ($N = 124$)

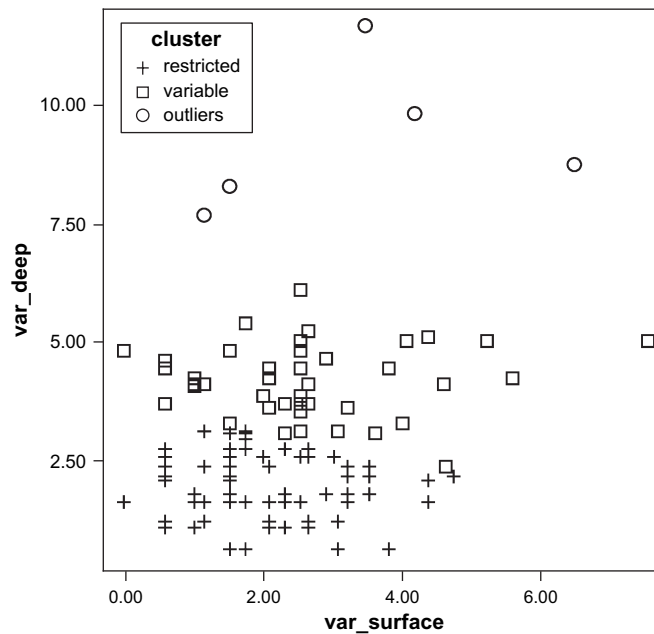|	Number of items	International business strategy	International finance & accounting	International marketing
Deep learning	7	23.69 (3.18)	20.50 (3.74)	22.59 (3.20)
Surface learning	6	16.27 (3.45)	18.42 (2.99)	17.22 (3.40)

Fig. 1. Variability in surface learning and variability in deep learning (scatter diagram).

form a separate cluster at the end. The cluster size is rather small, so it was not considered to be a third cluster and the two-cluster solution was preferred. However, the small cluster drew attention to another aspect of cluster analysis, that is, the detection of outliers. The small size could indicate that the students in this cluster are possible outliers. Further analysis indicated that their variability in deep learning was caused by extremely high or extremely low scores for deep learning in some courses. In this respect, these cases were not representative and were removed from the sample. As a result of the deletion the means and standard deviation of the variability in deep and surface learning came even closer.

To check the validity of the cluster solution, a split-file approach was used (Hair et al., 1998). The data file, without the outliers, was divided randomly into two groups. Each group was analyzed separately, revealing the following ag-glomeration figures for the successive numbers of clusters (4−1) (random1/random2): (4) 47/63, (3) 64/83, (2) 107/121 and (1) 165/207, which resulted in a final number of two clusters for each group. This supports the two-cluster solution.

The split-file approach was also used to cross validate the assignment of cases to the clusters, following the pro-cedure of Breckenridge (1989). For both groups (random1 and random2) the cases were classified on the basis of their centroids from the hierarchical cluster analysis. Subsequently, the cases in random1 were classified on the basis of the centroids in random2 and the other way around. Thus, each case was classified twice. Cohen's kappa was used to test consistency in clustering. Cohen's kappa for group random1 was 0.27 indicating a fair agreement, while for group random2 Cohen's kappa was 0.71 indicating substantial agreement.

Subsequently, a *K*-means cluster analysis was performed, setting the number of clusters to two and using the cen-troids from the hierarchical analysis as seeds. This analysis resulted in some changes in cluster membership. Statistical characteristics of both clusters are presented in Table 4.

Table 4
Mean (and standard deviation) of the variability in learning strategies scores per cluster and *t*-values for differences in strategies

Learning strategy	Variable cluster ($n = 43$)	Restricted cluster ($n = 76$)	t
Deep learning	4.09 (0.75)	1.81 (0.65)	17.4**
Surface learning	2.60 (1.49)	1.97 (1.00)	2.75*

*$p < 0.05$; **$p < 0.001$.

Cluster 1 (the variable cluster) was characterized by relatively high variations in both deep and surface learning. Cluster 2 (the restricted cluster) was characterized by rather small changes in both deep and surface learning. Variability in both deep and surface learning differed significantly between the two clusters, indicating that both variables were relevant for clustering. The position of cases belonging to both clusters can be found in Fig. 1.

Variability in learning strategies was due to differences in the learning strategies scores in the three courses. This raised the question: which courses caused the variability? We examined the patterns that students' learning strategies followed in the three courses. Students' deep learning strategies scores decreased from International Business Strategy to International Finance & Accounting and increased from International Finance & Accounting to International Marketing. This was also the case with respect to students' employment of surface strategies across courses — only in the opposite direction; in this case there was an increase of surface learning scores from International Business Strategy to International Finance & Accounting and a decrease from International Finance & Accounting to International Marketing. However, although the learning strategies differed across the courses, there was no significant difference in the average scores for deep and surface learning between the two clusters.

5.4. Differences in variability in the perceptions of learning environment between the clusters

One of the possible reasons for the differences in variability in learning strategies between the two clusters is the variability in the perceptions of the learning environment. For each of the five elements of the perceptions of the learning environment the variability was calculated. Subsequently, the scores for the two clusters were compared (see Table 5). Students in the variable cluster showed more variability in all perceptions of the learning environment than students in the restricted cluster. However, only two elements, namely clear goals, $t(117) = 3.21$, $p < 0.01$, ES = 0.62, and appropriate workload, $t(117) = 2.26$, $p < 0.05$, ES = 0.42, differed significantly between the two clusters.

5.5. Differences in the influence of the perceptions of learning environment on learning strategies between the clusters

Variability in the perceptions of the learning environment might have caused variability in learning strategies. The effect of the perceptions of learning environment on learning strategies is indicated by the slope of the regression line. For this reason we calculated the regression coefficients by using a linear mixed model approach that allows linear regression with repeated measures. There were several significant relationships between the elements of the perceptions of the learning environment and the learning strategies (see Table 6).

In both clusters, clear goals, appropriate workload, and independent learning correlated significantly with deep learning. Good teaching was significantly related only to deep learning in the variable cluster. In both clusters, only the perception of appropriate workload was significantly related to surface learning. Good teaching was significantly related to surface learning only in the restricted cluster. appropriate assessment showed a significant relationship only with surface learning in the variable cluster. The *t*-test was used to determine the significance of the differences in the regression coefficients between the two clusters. The *t*-values revealed that, for deep learning, four regression coefficients were significantly higher in the variable cluster as compared to the restricted one. For surface learning, the coefficients did not significantly differ between the two clusters.

Table 5

Mean (and standard deviation) of the variability in perceptions of the learning environment scores per cluster and *t*-values for differences in perceptions

	Variable cluster ($n = 43$)	Restricted cluster ($n = 76$)	t	ES
Good teaching	2.98 (1.64)	2.48 (1.45)	1.69	0.33
Clear goals	2.44 (1.10)	1.79 (1.05)	3.21**	0.62
Appropriate workload	3.65 (1.39)	3.04 (1.41)	2.26*	0.42
Appropriate assessment	1.41 (0.89)	1.36 (0.82)	0.30	0.06
Independent learning	2.62 (1.22)	2.20 (1.20)	1.84	0.35

*$p < 0.05$; **$p < 0.01$.

Table 6
Comparison of the Pearson correlation coefficients (and standard error) between learning strategy and perception of learning environment in the variable and restricted clusters

Perception	Deep learning			Surface learning		
	Variable ($n = 43$)	Restricted ($n = 76$)	T	Variable ($n = 43$)	Restricted ($n = 76$)	T
Good teaching	0.28** (0.10)	0.07 (0.05)	2.00*	0.12 (0.09)	0.11* (0.05)	0.05
Clear goals	0.62*** (0.11)	0.16* (0.07)	3.53***	−0.15 (0.11)	−0.10 (0.08)	−0.37
Appropriate assessment	−0.01 (0.17)	0.08 (0.09)	0.47	−0.32* (0.15)	−0.11 (0.10)	−1.19
Appropriate workload	0.42*** (0.09)	0.11** (0.04)	3.15**	−0.17* (0.08)	−0.21*** (0.05)	0.39
Independent learning	0.47*** (0.11)	0.21*** (0.04)	2.15*	0.12 (0.09)	−0.04 (0.07)	1.44

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

6. Discussion and conclusions

In previous studies, the variability in students' learning strategies was investigated. The relevant research brought about mixed results (Eley, 1992; Fazey & Lawson, 2001; Jones, 2002; Nijhuis et al., 2005; Vermetten et al., 2002; Wilson & Fowler, 2005). The aim of the present study was to identify groups of students who differed in the degree of variability in learning strategies. In this way it was possible to break through the usual split between stable vs. variable learning strategies. To guide our research we formulated five working hypotheses.

The first working hypothesis predicted that there would be variability in students' perceptions of the learning environment across the different courses. Indeed, we did find variability in students' perceptions of the learning environments of the three courses. However, the variability did not apply to all aspects of the learning environment. There were three significant differences in students' perceptions, which were in line with our tentative expectations and the findings of Nijhuis et al. (2005). First, perceived guidance given to students in terms of clear goals differed between the courses, mainly because of the high score in the International Business Strategy course. This high score could be explained by the kind of problems used in the course; these were characterized by clear-cut questions and detailed literature references. Second, appropriate workload had low scores in two courses. Students probably perceived high levels of workload in these two courses, because of the amount or difficulty of the literature (Finance & Accounting) or the kind of assignment − e.g., the case study in the International Marketing course. A high level of workload in International Finance & Accounting is in line with the findings of Tempone (2001). Finally, perception of independent learning was low in International Finance & Accounting. This course included neither any presentations, as in International Business Strategy, nor any rather open assignment, as in International Marketing, so this might have given fewer opportunities for students to shape their own learning. Two aspects related to the tutor, namely, good teaching and appropriate assessment, did not significantly differ across the three courses. It seems that differences in the implementation of PBL did not result in changes in students' perceptions of the tutorial work.

The second working hypothesis predicted that there would be variability in learning strategies across the different courses. The study showed that, indeed, variability in learning strategies across different courses exists. Even within the same instructional approach (PBL), and within the same academic discipline (International Business), significant differences in both deep and surface learning strategies were observed across the three courses. It seems that the variation in the learning strategies originated from differences among the courses. First of all, the low score for deep learning and the high score for surface learning in International Finance & Accounting were in line with previous findings by Booth et al. (1999) and Eley (1992). However, the differences in learning strategies can be explained by students' perceptions of the learning environment. A high score for clear goals in the International Business Strategy course might have resulted in higher levels of deep learning. A less appropriate workload, that is, high workload, probably caused the high score of surface learning in the Finance & Accounting course. If this were the case, then a high level of surface learning would be reported in the International Marketing course. However, this was not the case. A possible explanation could be that there is a difference between the quantity (a lot of literature in the International Finance & Accounting course) and the quality of the workload (a case study in the International Marketing course). Finally, the low score for independent learning in the International Finance & Accounting course might have caused the low levels of deep learning in this course.

The third working hypothesis predicted that there would be different groups of students with respect to the variability in learning strategies. With respect to the grouping of students on the basis of their variability in learning

strategies, two groups resulted from the cluster analysis: a "restricted" cluster and a "variable" cluster. The restricted group was characterized by low variability in deep as well as surface learning; the variable group had high variability in deep as well as surface learning. Therefore, no stable clusters were found, meaning that there was no variability at all. However, stability does not mean that there is no variability at all. It may mean that the differences in learning strategies cancel each other. Previous studies have found stability and variability for both deep and surface learning. This would result in four possible combinations. Theoretically, different levels of variability are possible – e.g., low, moderate, and high – resulting in different combinations of variability in deep and surface learning. This would imply that there would be even more than four clusters. Our study revealed, however, the existence of only two clusters.

With respect to learning strategies, both clusters showed the same pattern of variability for deep and surface learning (although inverted) over the different courses; therefore, it can be concluded that the variability originated from the same source, that is, the demands of the International Finance & Accounting course. The two clusters differed with respect to the scores of the learning strategies in the International Finance & Accounting course. Deep learning scored lower and surface learning scored higher in the variable cluster than in the restricted cluster. This resulted in high variability for both surface and deep learning, although the total average scores for both deep and surface learning did not differ significantly between the clusters. Although other studies (Jones, 2002; Wilson & Fowler, 2005) found differences in variability in students' learning strategies, based on a grouping in deep and surface learners, we found in our study that variability was not related to the students' level of deep or surface learning, but to the characteristics of the courses.

It should be also noted that in the cluster analysis there was one small group of students which was kept separate until almost the end of the clustering process. Due to its size and its degree of variability, this group was classified as an outlier. The question of whether this subgroup should be included in the calculations remains. If this is the case, two options are open for dealing with this subgroup: keep it as a separate cluster or include it as part of another cluster. Because, in cluster analysis, the number of clusters and the definition of outliers are liable to subjectivity (Hair et al., 1998), more research is needed to confirm the findings in this study.

The fourth working hypothesis predicted that clusters with different variability in learning strategies will differ in the variability in learning environment perceptions. The two clusters of students did indeed differ in variability in the perceptions of the learning environment. However, the differences were limited to variability in two perceptions: clear goals and appropriate workload. Students in the variable cluster exhibited significantly more variability in their perceptions of clear goals and appropriate workload than students in the restricted cluster. It seems that the students in this cluster observed more differences between the three courses than students in the restricted cluster. Students in the restricted cluster seem to have more stable perceptions of the learning environment. There were no significant differences between the two clusters for good teaching, appropriate assessment and independent learning. As these perceptions were not content-related, they did not give rise to differences in variability.

The fifth working hypothesis predicted that clusters with different variability in learning strategies should differ in the relationship of the perception of the learning environment with learning strategies. The findings of the study showed that the relations of the perceptions of the learning environment with deep learning differed between the two clusters. In the variable cluster the regression coefficients for perceptions of good teaching, clear goals, appropriate assessment, and independent learning were significantly higher than in the restricted cluster. This indicates that in the variable cluster changes in these perceptions resulted in higher change of deep learning than the same change in the restricted cluster. Our findings support the suggestion made by both Trigwell et al. (1996) and Vermetten et al. (2002) that some students are more influenced by the environment than others. This means that the students' sensitivity to features of the learning environment is important for enhancing deep learning. Changing deep learning in the restricted cluster seems to be less effective, and other approaches, such as counselling, might be more appropriate. Future research should pay attention to students with different levels of adaptability to the environment.

The relations of good teaching, clear goals, and independent learning with deep learning were in line with theory (Lizzio et al., 2002; Wilson et al., 1997). The relationship between appropriate workload and deep learning is not generally supported by empirical evidence; however, it was found in other studies (e.g., Nijhuis et al., 2005). This relationship could be explained as follows: the less time pressure there is on students, the more time they have to make associations between topics (deep learning). In the restricted cluster, the relationship between good teaching and deep learning was missing.

Comparison of the coefficients between perceptions of the learning environment and surface learning did not result in any significant differences between the two clusters. This suggests that differences in variability in surface learning

in the two clusters originated from some other source. In this respect the variability in the perception of appropriate workload, which was discussed under the fourth working hypothesis might be an explanation for differences in the variability in surface learning.

For surface learning, its relationship with appropriate assessment and appropriate workload was in line with theory (Lizzio et al., 2002; Wilson et al., 1997). The relationship, especially the positive sign of the coefficient between surface learning and good teaching in the restricted cluster was not expected. A possible explanation could be that the better the teacher is, the more a student learns, whether this is deep or surface learning.

Our sample was restricted to three courses in an International Business curriculum. Replications of the present study might answer the question of whether the pattern of relationships is just characteristic of the present sample or if it can be observed in samples covering other disciplines. Another direction for future research might be to use more complex models, as our analysis of the regression coefficients was based on bivariate relationships. Other measures of variability can also be used.

In summary, it seems that differences in variability in deep learning between the restricted and variable clusters can be explained in two ways. First, in the variable cluster rather than in the restricted one, four of the students' perceptions of the learning environment had a strong impact on deep learning. Second, two perceptions, clarity of goals and appropriate workload, varied more strongly in the variable cluster than in the restricted cluster, causing more variability in learning strategies in the variable cluster. With respect to differences in variability in surface learning between the two clusters, it seems that these differences were mainly caused by the differences in variability in the perceptions of clear goals and appropriate workload. However, these perceptions were only weakly related to surface learning in both clusters. There were no significant differences in the regression coefficients between the two clusters.

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