Vol 5, No. 2, May 2009, pp. 35-51

Reflecting Education
http://reflectingeducation.net

Alternative data-analysis techniques in research on student learning: illustrations of a person-oriented and developmental perspectives

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ABSTRACT

Studies on student learning in higher education from a student approaches to a learning tradition have yielded valuable insights, although research remains inconclusive on how to incite a deep approach in students. To broaden our insights into student learning, two alternative research perspectives are explored: 1) a person-oriented approach to data analysis aimed at identifying subgroups of students with similar learning profiles, and 2) a developmental approach interested in the stability and variability of students' approaches to learning. The usefulness and value of combining these perspectives is illustrated using research findings from two recent studies in a Flemish context. The first study investigated the development of learning profiles in a specific course using the Revised Two Factor Study Process Questionnaire (R-SPQ-2F), based on the model of John Biggs (2001). The second study explored the evolution in learning patterns throughout a whole teacher-education programme using Jan Vermunt's Inventory of Learning Styles (ILS) (Vermunt, 1996). Both studies identified the existence of sub-groups of students with similar learning profiles and point towards different developmental trends for these profiles. Moreover, the second study showed that some parts of students' learning patterns are more prone to changes than others. For educational practice, the exploration of these profiles and the monitoring of their development might prove an interesting diagnostic tool for choosing, designing and implementing adaptive instructional methods and remedial trajectories in an evidence-based way.

INTRODUCTION

Over the last few decades, a lot of research effort has been invested in exploring the ways in which students learn in higher education. This research stems from a variety of research traditions (Biggs, 1993; Entwistle & McCune, 2004) and has evolved in different directions. A large number of studies have been carried out in diverse areas, such as: cognitive aspects of learning (Kolb, 1984; Sadler-Smith, 1996); learning conceptions or views on learning (Van Rossum & Schenk, 1984), education, and specific learning strategies (Säljö, 1979); aspects of self-regulation (Boekaerts et al., 2000; Pintrich & De Groot, 1990); meta-cognition (Flavell, 1987); and motivational aspects (Entwistle, 1988). A shared feature of many of these studies is the search for relationships between various aspects of learning and an attempt to arrive at integrative models of learning (Biggs, 1993; Meyer, 1998).

One of the research traditions interested in student learning in higher education is the 'Students' Approaches to Learning' tradition (the SAL tradition). It is founded on the phenomenographical studies by Marton and Säljö in the 1970s (Marton & Säljö, 1976). Research in this tradition generally focuses on differences in the way students engage in learning or handle learning tasks as reported by the students themselves (Biggs, 2001;

 ISSN 1746-9082

Schmeck, 1988). Representatives of this tradition mostly concur on the viewpoint that there are qualitatively different ways in which students go about learning and that these differences in study processes are associated with qualitatively different learning outcomes (Biggs, 1979). There is also a general acceptance of the belief that students have a disposition towards a certain approach to learning, sometimes called their *learning orientation* (Biggs, 2001; Entwistle, 1988) or *learning style* (Vermunt, 1996).

However, the 'approaches to learning' students use in specific learning situations are not solely determined by their general preferences, but the result of an interaction between their perception of the learning context, their disposition and other learner characteristics (Biggs, 2003; Entwistle, 1991; Entwistle & Ramsden, 1983). Moreover, research has also shown the difficulty of changing students' approaches to learning towards a more preferred deep approach or meaning-directed learning pattern (Marton & Säljö, 1997), even within so-called 'new learning environments' (Gijbels et al., 2008) or innovative learning environments aimed at fostering such approaches (Gijbels & Dochy, 2006; Struyven et al., 2006). This finding not only seems to necessitate more research on students' approaches to learning but also points towards the need to deepen our understanding of the complex processes of learning in higher education by using other research perspectives and different data-analysis techniques. In recent studies a number of these alternative approaches can be discerned, two of which seem very promising for broadening our insights:

1. The use of a person-oriented perspective in data analysis, taking into account the multidimensionality of learning and aiming at identifying sub-groups of students with similar learning profiles within a student population.
2. The use of longitudinal designs in an attempt to clarify questions about the stability and variability of students' approaches to learning.

This paper illustrates how the two alternative perspectives mentioned above can be integrated and implemented in research, using two models from the SAL tradition: the Biggs model and the Vermunt model. It therefore starts by exploring these models as part of the SAL tradition. Next, it elaborates on the value of using person-oriented data-analysis techniques and longitudinal designs, on the basis of results of earlier studies in the fields using these perspectives. It concludes that research combining both approaches is scarce. The value of this combination for broadening our understanding of student learning is illustrated by two recent studies in the context of Flemish teacher education, one study using the Biggs model and the other one using the Vermunt model. Finally, on the basis of this research, some conclusions are drawn for both research and educational practice.

TWO EXEMPLARY MODELS WITHIN THE 'APPROACHES TO LEARNING'-TRADITION

Despite an agreement on the general framework of the SAL tradition (see above), a multitude of models can be discerned within this tradition, placing emphasis on different aspects of learning and using a variety of different but related concepts and dimensions (Jonassen & Gabrowski, 1993). Two internationally acclaimed researchers within this

tradition are John Biggs from Australia and Jan Vermunt from the Netherlands. Both devised their own models and accompanying inventories.

The Biggs model

The Biggs model (Biggs, 2003) makes a general distinction between a deep and a surface approach to learning. A *deep* approach to learning is associated with students' intentions to understand and to engage in meaningful learning, focusing on the main themes and principles and using strategies that are appropriate for creating such meaning. The *surface* approach to learning, on the other hand, refers to students engaging in learning in an inappropriate superficial way, based on motives or intentions that are extrinsic to the real purpose of the task (Biggs, 2003; Entwistle, 1991; Trigwell & Prosser, 1991). Based on this theoretical framework, Biggs (1987) devised the Study Process Questionnaire (SPQ), which was recently refined by Biggs et al. (2001) into the *Revised two Factor Study Process questionnaire* R-SPQ-2F. The R-SPQ-2F asks students about their attitudes towards learning and their usual way of studying. This self-report questionnaire contains 20 items and is scored on a five-point Likert scale, ranging from (1) 'This item is never or only rarely true of me' to (5) 'This item is always or almost always true of me'. It measures students' deep and surface approaches to learning with 10 items for each scale.

The Vermunt model

In his original model Jan Vermunt attempted to provide a more comprehensive and integrated account of learning by bringing together four different components of learning, namely: cognitive processing strategies, regulation strategies, conceptions of learning, and orientations to learning (Vermetten et al., 1999; Vermunt, 1998). Each of these components contains several dimensions as Table 1 shows. Using factor analysis, Vermunt identified four recurring patterns based on the position of students on each of the four components. He labelled these patterns as 'learning styles': an undirected style, a reproduction-directed style, a meaning-directed style, and an application-directed style and stated that these styles represented students' general preferences in learning for a specific period of time (Vermunt, 1996). However, as the notion of learning styles is mostly associated with invariant personality characteristics and a more trait-like view on learning, Vermunt and his colleagues recently suggested the use of the more neutral term 'learning patterns' in order to take into account the modifiability of students' learning styles (Vermunt & Minnaert, 2003; Vermunt & Vermetten, 2004). The term 'learning patterns' will be used throughout this paper.

Scales	*Items*	*Example items*
Processing strategies		
Deep processing	11	I compare conclusions from different teaching modules with each other.
Stepwise processing	11	I learn definitions by heart and as literally as possible.
Concrete processing	5	I use what I learn on a course in my activities outside the programme of study.
Regulation strategies		
Self-regulation	11	In addition to the course material I also study other literature which is related to the course content.
External regulation	11	I study according to the instructions given in the course material.
Lack of regulation	6	I confirm that I find it difficult to establish whether or not I have sufficiently mastered the course material.
Learning conceptions		
Construction of knowledge	9	I have to establish links within the study material for myself.
Intake of knowledge	9	It is up to me to repeat the course material as often as necessary until I know it sufficiently.
Use of knowledge	6	I have to be able to use what I am learning to solve practical problems.
Stimulating education	8	The course instructor must encourage me to find my own solutions when I encounter problems.
Co-operative learning	8	I prefer to work together on tasks with other students

Table 1: ILS scales, number of items (N) and example items

Vermunt devised the Inventory of Learning Styles (ILS) as a self-report measurement instrument for his four learning patterns and related dimensions. In this questionnaire students are asked to report about their habitual learning strategies and their learning conceptions: 27 of the items relate to processing strategies; 28 of them relate to regulation strategies; 40 of the items relate to learning conceptions, and 25 of the items relate to learning orientations. The processing and regulation strategies items are scored on a five-point Likert scale, ranging from (1) 'I never or hardly ever did this' to (5) 'I (almost) always did this'. Learning conceptions and learning orientation items are scored, ranging from (1) 'I completely disagree' to (5) 'I completely agree'. Table 1 provides an overview of the various scales with an example for each item.

Relationship between both models

A comparison between both models suggests that both authors use different but somewhat related concepts and dimensions to describe student learning (see Table 2 for an overview). Based on empirical evidence, Vermunt (1998) states that his 'meaning-directed' and 'reproduction-directed' learning patterns were to some extent related to what Biggs regards as 'deep' and 'surface' approaches to learning.

	Biggs' model	Vermunt's model
Central concept and dimensions	***Approaches to learning*** - Deep approach to learning - Surface approach to learning	***Learning styles/learning patterns*** - Meaning-directed learning pattern - Reproduction-directed learning pattern - Undirected learning pattern - Application-directed learning pattern
Learning strategies	- Deep learning strategies: looking for underlying meaning, relating,… - Surface learning strategies: rote learning)	- Deep processing strategies - Stepwise processing strategies - Concrete processing strategies
Regulation strategies	*Not explicitly incorporated in the concept*	- Self-regulation - External regulation - Lack of regulation
Learning conceptions	*Not explicitly incorporated in the concept*	- Construction of knowledge - Intake of knowledge - Use of knowledge - Stimulating education - Co-operative learning
Learning orientations	- Intention to understand (intrinsic) - Intention to get task done with minimal effort (extrinsic)	- Personally interested - Certificate and Self-test oriented - Vocation oriented - Ambivalent

Table 2: Comparison of scales and concepts of Biggs' (2003) and Vermunt's (1998) models

ALTERNATIVE PERSPECTIVES IN RESEARCH ON STUDENT APPROACHES TO LEARNING

Recent studies, using both the Biggs and the Vermunt model have attempted to broaden and deepen the understanding of students' approaches to learning, using alternative research perspectives like person-oriented data-analysis techniques or longitudinal research designs.

Investigating learning profiles using person-oriented data-analysis techniques

Most studies in the SAL tradition use a dimension or variable oriented approach in data-analysis. These techniques aim at identifying dimensions of learning (using factor analysis) and exploring the relationship between these (separate) dimensions and variables in the learning environment or learning outcomes (in most cases applying variants of the general linear model such as ANOVA or regression analysis). Research using this perspective has yielded interesting insights into the dynamic nature of learning of students in higher education. For instance, studies in the last decade have clearly revealed the pivotal role assessment practices play in the learning process (Dochy & McDowell, 1997; Gibbs et al.,

2003) and have pointed out that students' perceptions of the learning environment matter more in the way they engage in learning than the actual learning environment (Entwistle, 1991; Entwistle & Ramsden, 1983). Aspects in the learning environment that research found related to this perception are, amongst others, the quality of teaching and freedom in learning (Ramsden, 1988), the clarity of goals and the relevance of study materials (Nijhuis et al., 2005), the academic workload (Struyven et al., 2006), and the existence and quality of feedback (Segers et al., 2008). Other research has shown the importance of 'process-oriented' education, aimed at promoting a constructive friction between students' levels of self-regulation and teachers' levels of external regulation (Vermunt & Verloop, 1999; Volet et al., 1995).

The above type of studies have pointed out the influence of many personal and contextual factors on (separate) learning dimensions. However, the way in which most students learn cannot be characterised by a single dimension (Van Steenkiste et al., in press). Students do not learn in solely a deep or surface manner, but in most cases combine typical learning strategies of both approaches in a specific relationship. The repertoire of learning strategies that students acquire and apply and their interrelationship constitutes their relatively unique 'learning profile'. In a student population several sub-groups of students with similar learning profiles might be discerned. To identify these sub-groups using data from questionnaires, a person-oriented approach (Magnusson, 1998), using data-analysis techniques such as cluster analysis, is needed. The primary aim of these techniques is to classify students into (sub-) groups with similar learning profiles (Hair et al., 1998). Investigating the relation between students' learning profiles and other variables such as instructional methods or learning outcomes is likely to yield valuable information that is complimentary to insights gained by a variable oriented approach (Fortunato & Goldblatt, 2006). It allows for example to look at teaching and learning processes in higher education at a more fine-grained level by looking at sub-groups and helps at identifying groups of 'at risk'-students (Entwistle et al., 1991). However, little prior attention has been devoted to this person-oriented perspective by researchers.

Meyer (1991) was a harbinger of this perspective when he introduced the notion of 'study orchestrations' in the early nineties. He used this concept to indicate contextualised patterns in learning that individual students or groups of students adopt and that are sensitive to both students' perceptions of the learning environment and their learning conceptions. A small but growing number of studies expanding on this concept have revealed that qualitative differences in the consonance of these orchestrations are related to differences in academic learning outcomes (Entwistle et al., 1991; Lindblom-Ylänne & Lonka, 1999; Rodríguez & Cano, 2006). Lonka and Lindblom-Ylänne (1995) combined a quantitative and qualitative perspective on orchestrations. They used cluster analysis based on questionnaire responses to identify four different profiles (which they termed *reproducing orchestration, both-low orchestration, both-high orchestration, and meaning orchestration)* and, in a next step, interviewed students to acquire an in-depth understanding of how individual students interacted with their learning environment. Their study showed that less desirable profiles may develop when a conflict arises between the demands of the learning environment and students' personal goals.

A number of authors have applied a similar person-oriented perspective using the Vermunt model. Wierstra and Beerends (1996), for instance, found three clusters of university students based on the ILS: a 'self-regulated/meaning oriented' cluster, an 'externally regulated/reproductive' cluster, and a 'flexible/versatile' cluster. The last of the three mentioned clusters can also to some extent be related to the versatile learning pattern already distinguished by Pask (1976). Other researchers (Vermetten et al., 2002; Van Petegem et al., 2005) found similar clusters to the ones mentioned by Wierstra and Beerends (1996), but additionally also identified an 'inactive' cluster, consisting of students whose learning patterns are characterised by low levels of learning activities.

Studying the development of students' approaches to learning using longitudinal research designs

Besides the focus on a person-oriented perspective in research, there is also a (renewed) research interest in the development of students' approaches to learning and learning patterns throughout higher education. Although questions about the degree of stability and variability in students' approaches to learning have been posed for over 20 years (Entwistle, 1988; Watkins & Hattie, 1985), longitudinal research that looks into the development of these approaches remains scarce.

Some studies have looked at the development of students' approaches to learning within a specific learning environment, using Biggs' model. However, the results of these studies are inconclusive. Some studies (e.g. Albanese & Mitchell, 1993; Biggs, 1991; Blumberg, 2000), for instance, conclude that new learning environments, such as problem-based learning, support the development of deep approaches to learning. Other and more recent studies (e.g. Gijbels & Dochy, 2006; Nijhuis et al., 2005; Struyven et al., 2006) found the opposite, namely that an educational innovation aimed at fostering deep approaches to learning resulted in more surface approaches to learning. A few studies explored student learning across learning environments. Cross-sectional data comparing students from different study years show that older students report a higher use of the deep approach and the achieving approach and a lower use of the surface approach (Biggs, 1987; Gow & Kember, 1990). A longitudinal study by Zeegers (2001) during a three-year period indicated that students' approaches to learning changed as a result of the learning experiences they encountered. His results indicated a significant decline over time in the achieving approach. Moreover, he found an initial decline in the deep approach, followed by a subsequent increase of this approach. Finally, the surface approach increased during the first year, but changed little overall.

Longitudinal research into learning patterns using Vermunt's model, is also scarce, but paints a slightly more hopeful picture for students' changes in learning during higher education. Studies using a longitudinal perspective show that learning patterns can be subject to change and that the meaning-oriented learning pattern increases during higher education degree courses (Busato et al., 1998; Vermetten et al., 1999; Vermunt &Minnaert, 2003).

To conclude, in the previous paragraphs some alternative research perspectives within the SAL research tradition were put forward and it was shown that, although research using these approaches is not abundant, these perspectives can help the field in developing a broader understanding of the complex process of learning in higher education. However, research combining both a person-oriented and a developmental perspective is, to our knowledge, almost non-existent. This paper aims at exploring this amalgamation and at illustrating the value of this combined perspective by reporting the main results of two studies in a Flemish context.

ILLUSTRATIONS OF A COMBINED PERSON-ORIENTED AND DEVELOPMENTAL PERSPECTIVE

Case 1: the development of learning profiles in a teacher-training course

Vanthournout et al. (2008) investigated the existence of different 'study approach profiles' and the development of these profiles within a specific course module of a university teacher-training course.

In their study, the following questions were posed: 1) Do students change their approaches to learning after experiencing a specific student-activating learning environment? 2) Can sub-groups of students with similar study approach-profiles be distinguished? 3) Do students with different learning profiles evolve differently in their approaches to learning when confronted with the same student-activating learning environment?

At the start and at the end of the semester, 208 students completed the most recent version of Biggs' Study Process Questionnaire, the R-SPQ-2F, for a specific course module. Initial paired sample t-tests on differential scores for both the surface and the deep approach indicated that the whole group of students did not change their approach to learning significantly during the learning experience.

Cluster analysis was then used to distinguish between sub-groups of students with different study approach profiles. Five such profiles were established: 1) a *'High Ambivalent Profile'* (HAP), bringing together students with high scores on both the deep approach scale and the surface approach scale. This profile bears resemblance to a 'both high orchestration' profile, identified by Lonka and Lindblom-Ylänne (1995); 2) a *'Deep Approach Profile'* (DAP), grouping students with a high score on the deep approach scale and a low score on the surface approach. This cluster most closely resembles the 'deep approach to learning' as presented in the students' approaches to learning theory (Biggs, 2003); 3) a *'Moderate Ambivalent Profile'* (MAP) with students having a moderate score on both the deep approach scale and the surface approach scale; 4) a *'Surface Approach Profile'* (SAP) clustering students with a moderate score on the deep approach scale and a high score on the surface approach scale. This cluster most closely bears resemblance to the 'surface approach to learning' as featured in theoretical frameworks; and 5) a *'Fallen Angels Profile'* (FAP) incorporating students with moderate to low scores on both the deep

approach scale and the surface approach scale. The latter cluster might to some degree be similar to the 'both-low orchestration' profile of Lonka and Lindblom-Ylänne (1995).

Paired sample t-tests on differential scores of the deep approach and surface approach scales for these clusters indicated that approaches to learning of students with a different profile developed differently throughout the learning environment and these varied evolutions were statistically significantly different from each other. Generally, the approaches to learning for the different profiles seemed to converge throughout the course module. Students belonging to profiles with a high score on a deep approach (DAP, HAP) significantly decreased their deep approach during the course, while students belonging to profiles with a low score on a deep approach (SAP, FAP) significantly increased their deep approach. Students who belonged to the moderate approach profile (MAP) did not change. A similar pattern could be distinguished for the surface approach to learning, where the SAP and HAP students significantly decreased their scores on the surface approach, while the FAP and DAP students significantly increased their scores. Also in this case, the scores of students belonging to the MAP did not change significantly. So, although initial analyses at the whole group level revealed no significant changes in the approaches to learning, analyses at sub-group level indicated significant differences in developmental trends for students with different learning profiles.

Case 2: change and stability in learning patterns in teacher education

Donche and Van Petegem (2009) longitudinally explored the development of learning patterns during a complete pre-service teacher education programme. Vermunt's ILS was administered to 236 students twice as a class activity, once at the beginning of the first year and again in the third year at the end of their study. The following research questions guided the study: 1) Which learning patterns can be found among first- and third-year student teachers? 2) How do learning dimensions and learning patterns develop between the first and the third year? 3) To what extent are learning components and learning patterns subject to change during a three-year education programme?

It was decided a priori not to include the ILS scales on learning orientations in this study as previous research shows that this dimension of learning exhibits weaker correlations with other dimensions of learning patterns (Boyle et al., 2003; Vermunt, 1998). A cluster analysis (Ward, 1963) was carried out with the remaining 11 ILS scales. Three learning patterns could be distinguished. Students in the first cluster are labelled as having a *'reproductive/undirected' learning pattern*. This cluster consists of students who see education primarily as the intake of knowledge. In terms of regulation, this group of students appears to be the least self-regulated. They most often process learning content using stepwise processing strategies. Students in the second cluster are categorised as having a *'meaning-oriented' learning pattern*. This group of learners reports does not see education primarily as the intake of knowledge. They exhibit a preference for self-regulation and, with regard to the processing of learning content, generally use deep and concrete processing strategies. Students in the third cluster are described as having a *'flexible' learning pattern*. This cluster groups students who see education primarily as the construction and use of knowledge. With regard to the regulation of learning characteristics

these students use both self-regulation and external regulation. In the area of processing strategies these students make use of deep, stepwise, and concrete processing strategies. The three identified learning patterns are to some extent in line with former research. The 'flexible' learning pattern corresponds with the 'flexible/versatile' cluster identified by Wierstra and Beerends (1996). The 'meaning-oriented' and 'reproductive/undirected' learning patterns correspond with the 'surface/undirected' and 'deep' cluster identified by Vermetten and colleagues (2002). However, a cluster formed by 'inactive' learners which Vermetten and colleagues (2002) identified was not found in this study.

Developments in the learning patterns were explored by calculating paired sample t-tests on the 11 ILS scales and by computing effect sizes, followed by paired sample t-tests on differential scores for each of the learning pattern clusters. Analyses show that meaning-oriented learning characteristics increase over time, accompanied by a decrease in undirected learning characteristics. The learning patterns of students developed differently according to the learning pattern already adopted in the first year. Students who exhibited a reproductive/undirected learning pattern during the first year reported less characteristics of an undirected pattern and developed towards a more meaning-oriented pattern. First-year students who exhibited the characteristics of a flexible learning pattern appeared to learn in a more meaning-oriented way in the third year. Finally, students who already exhibited a meaning-oriented learning pattern in the first year seemed to develop this pattern more during the programme.

The results of the paired sample t-tests also revealed that some dimensions of learning are more subject to change than others. For instance, data analysis did not reveal significant changes in the level of external regulation, stepwise processing/surface learning and a number of learning conceptions such as 'construction of knowledge' and 'use of knowledge', which is in line with previous research (Vermunt & Vermetten, 2004).

CONCLUSIONS AND DISCUSSION

The present paper set out to explore and illustrate alternative research perspectives within the SAL tradition. We identified two promising perspectives: 1) a person-oriented approach aimed at looking at approaches to learning at a sub-group level through the use of learning profiles, and 2) a developmental approach, interested in the development, stability and variability of learning within and across learning environments. It was argued that additional insights in the complex process of learning could be reached by combining these perspectives. This was subsequently illustrated using research results from two recent studies in a Flemish context.

The results of both studies point to the value of looking at approaches to learning at a sub-group level, by identifying several 'profiles' of students with similar learning patterns. Vanthournout and colleagues (2008) make a distinction between five such profiles using the R-SPQ-2F (a high ambivalent profile, a deep approach profile, a surface approach profile, a moderate ambivalent profile, and a fallen angels profile), while Donche and Van Petegem (2009) distinguished between three learning patterns on the basis of the ILS (a

reproductive/undirected pattern, a meaning-oriented pattern, and a flexible pattern). Both studies also indicate that students who exhibit different learning patterns or profiles at the start of a course or teacher training programme develop their approach to learning differently. The study of Vanthournout and colleagues (2008) shows this within a specific course, while Donche and Van Petegem (2009) gather evidence for differences in development across a whole programme. Results of the last study also indicate that some aspects of learning, like learning conceptions or reproduction-oriented learning strategies, are relatively stable across time. This result is in line with earlier research on learning conceptions (Busato et al., 1998; Vermetten et al., 1999). The stability of the reproduction-oriented learning strategy, accompanied with the increase in meaning-oriented strategies, might point to the necessity of both strategies for succeeding in this specific programme. It might indicate that students not only broaden their strategies, but also advance in their capacity to judge what strategies are most suited for a specific learning environment. The fact that the first study showed that the approaches to learning of students with different learning profiles converged after having experienced the same learning environment, might be considered as additional support for this hypothesis

Additionally, the results of these studies refine to some degree the findings of earlier research in which no significant changes or changes towards a surface approach were reported (Gijbels & Dochy, 2006; Nijhuis et al., 2005; Struyven et al. 2006), as both point out that a general tendency of change in an undesired direction or a lack of change at the whole-group level does not imply that there are no sub-groups of students who have changed their learning patterns towards a more desirable profile. Moreover, the results of these studies in an exploratory way show the changeability of students' learning patterns within and across learning environments (at least to a certain degree).

Although these studies report some interesting findings and trends, results should not be overstated until they are repeatedly reproduced under different conditions. More research on the development of student learning in higher education with person-oriented data-analysis techniques is needed to validate and extend these findings. Moreover, both studies were based solely on the use of self-report questionnaires in order to ascertain differences and developments of student learning. As is well known, these inventories do not measure actual learning behaviour, but primarily students' disposition towards a certain approach to learning or learning patterns. This was deemed sufficient for the exploratory studies in this paper. However, to gain a more thorough understanding of the actual processes taking place, the use of a mixed-method design (Tashakkori & Teddlie, 2003) which combines quantitative and qualitative data is necessary. Finally, the studies reported in this paper measure learning at two points, perhaps suggesting wrongfully that the development of learning patterns takes place in a gradual, linear, and phased manner. Therefore, more large-scale longitudinal research using multiple measurement points is needed, investigating possible transitional phases in the development of learning approaches and patterns (Bijleveld et al., 1998).

For educational practice, the results of these studies demonstrate the value of a person-oriented and developmental perspective and the integration of these approaches. They stress the importance of not perceiving a student population as a homogeneous group that

responds to instructional methods in a uniform way, as some research seems to suggest. Our results indicate that it might well be that the same teaching-learning environment stimulates some students to adopt a more desirable approach to learning, while others revert to less desirable approaches. Vermunt and Verloop (1999) expressed this idea in their notion of friction. They distinguish between two kinds of friction, a constructive and a destructive one. Constructive friction occurs when a teaching-learning environment presents a challenge for students and stimulates them to adopt more deep or self-regulated learning strategies. Destructive friction indicates a grave discrepancy between expected and possessed learning strategies leading to negative feelings in students, such as uncertainty or boredom and resulting in a decreased chance of postulated learning strategies being acquired or applied. It might well be that the same instructional method causes constructive friction for one sub-group of students, while generating destructive friction for others. Our results can be useful to plead for more adaptive learning environments and a higher degree of within-classroom differentiation. A person-oriented perspective and learning profiles are valuable as a diagnostic tool in designing effective adaptive learning trajectories and efficiently developing learning environments that take into account different sub-groups of students. For the practitioner learning profiles provide an interesting cross-section of their student population, identifying not only sub-groups of strong learners but also groups of at risk students. Remedial trajectories can consequentially be pinpointed more accurately on the learning profiles of these students. Moreover, information on the frequency of each of the occurring profiles can easily be obtained, making it possible to tailor instructional methods to the learning profiles of the most frequently occurring sub-groups. At the same time complementary instructional activities for groups with different learning profiles can be designed in an evidence-based way.

To conclude, the use of a developmental perspective is also important for educational practice, not only because it uncovers stable and changeable aspects of learning patterns but also because it offers the possibility the impact of instructional methods not only on a short term, but also on a long term, thereby excluding generation effects (Vermetten et al., 1999). An investigation of these long term effects of instructional methods is essential for gaining an accurate impression of its impact on student learning. Students seem to need a period of time to adapt their approaches to learning to changing demands in the learning environment and take in new learning strategies into their repertoire. The conflict between learning environment demands and students' habitual ways of learning is what Lonka and Lindblom-Ylänne (1995) have put forward as a possible cause for dissonant study orchestrations and reduced academic performances. Van de Watering (2006) hypothesises that the experience of a new learning environment leads to uncertainty and causes these students to initially revert to approaches to learning they are well used to, which in most cases is the surface approach to learning. Therefore, evaluating only the short term impact of new instructional methods might produce a distorted image of changes in students' learning processes. To gain an accurate view, the long term effects also have to be taken into account.

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