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Learning pattern development throughout higher education: A longitudinal study

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1. Introduction

Over the years, research on student learning has evolved in many directions, like the investigation of learning patterns: ways in which students habitually approach their learning (Jonassen & Grabowski, 1993). Research shows that students' learning patterns are influenced by-a large number of-personological and environment-related factors (e.g. Entwistle, McCune & Hounsel, 2003; Watkins & Hattie, 1981). This generates discussion on whether learning patterns are 'trait or state'. Messick (1996) for example argues that learning patterns are fixed personality-related characteristics which are difficult to change in the context of education, while others stress the relative variable or dynamic nature of learning patterns (e.g. Meyer & Muller, 1990; Vermetten, Lodewijks, Vermunt, 1999). According to the Vermunt model of learning patterns (see also Vermunt, 1998) this variability may differ among learning pattern components. According to this theory, a learning pattern¹ is characterised by an interrelated ensemble of components such as the cognitive processing strategies habitually used by students, how students regulate their learning processes, their learning conceptions and their motives for study. Not all learning pattern components (learning conceptions, learning orientations, regulation and processing strategies) are considered to be stable according to this model. The cognitive processing and regulative strategies for instance are assumed to be less stable than learning

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ABSTRACT

Research on learning pattern development in higher education contexts is scarce. This longitudinal study seeks to address this issue by analysing the development of students' learning patterns throughout University College. Vermunts' Inventory of Learning Styles was used to assess individual differences in learning conceptions and learning strategies. By examining intra-individual changes in learning patterns we expected to find developmental trends within learning patterns. Results show that meaning oriented learning increases over time and undirected learning decreases. Some learning patterns are however more subject to change than others. The development of learning patterns was found to be relative and dependent on the learning pattern which students have already acquired in the first-year of University College. © 2010 Elsevier Inc. All rights reserved.

conceptions and learning orientations. Also processing and regulation strategies are expected to show a greater correlation with environment-related factors than learning conceptions. Learning patterns are thus not to be viewed as immutable in this model.

1.1. Investigating learning pattern development

The rather scarce longitudinal research into learning patterns in higher education has indicated that learning patterns can be subject to change (Busato, Prins, Elshout & Hamaker, 1998; Severiens, Ten Dam, & Van Hout Wolters, 2001; Vermetten et al., 1999; Vermunt & Minnaert, 2003). As to the direction of this change, some authors have stated that meaning oriented or deep learning increases during higher education degree courses (Busato et al., 1998; Vermetten et al., 1999; Watkins & Hattie, 1981). It is often assumed that at the end of higher education, students rely more on deep processing strategies, are more self-regulated and regard learning more as the construction of knowledge. However, longitudinal studies on these learning patterns most often examined the changeability of learning patterns over a short time period (less than 12 months). As a consequence, little is known about the changeability of learning patterns throughout higher education. So far, short time period studies reported changes at the level of learning patterns or their components, in the direction of meaning oriented learning. However, it can be questioned whether this is the case for all students. Since meaning oriented learning can be related to study success (e.g. Boyle, Duffy, & Dunleavy, 2003; Vermunt, 2005), it may be that students who already acquired a meaning oriented learning pattern by the start of higher education will not or change in a lesser extent their learning pattern throughout higher education. It is important to empirically investigate whether learning pattern development is related to the learning pattern which

¹ Vermunt initially used the term 'learning style'. However, in order to take into account the modifiability of students' learning styles Vermunt and Minnaert (2003) propose the use of a more neutral term 'learning patterns' which we also use in this article.

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students exhibit on entering higher education and if different developmental trends can be distinguished.

1.2. This study

By means of a repeated measurement study, using three measurement periods and which takes place within a long time period (>24 months), we aim to investigate three hypotheses (H1–3) which are important for further theory development on how learning patterns develop throughout higher education. We expect that: (H1) more stable assumed components of learning patterns such as learning conceptions (Vermunt, 1998) will be subject to change because of the larger time period used in this study; (H2) meaning oriented learning increases during higher education, which is based upon former ILS research findings (e.g. Vermetten et al., 1999); and (H3) developmental trends of learning patterns are different according to the learning patterns which students already have acquired when entering higher education.

2. Methodology

2.1. Design and respondents

The study took place in eight bachelor programmes² in one Flemish (Dutch speaking part of Belgium) University College. One cohort of students was followed during the three years of study. At the start of the first year, 1.039 students participated (response = 74%). The same cohort was questioned again at the start of the second and the third year. From the initial 1.039 students, 254 students participated in all three waves of data collection (subsample 1). From 280 of the initial 1.039 students we were able to gather data at the first and third wave (subsample 2).

2.2. Measurements

Learning patterns were assessed by investigating students' learning conceptions on the one hand and learning strategies on the other hand. The scales used in this study were based upon the self-report questionnaire 'Inventory of Learning Styles' (ILS; Vermunt, 1998). Four different learning conceptions were questioned, being intake of knowledge (e.g., "To me, learning means trying to remember the subject matter I am given"; 9 items; $\alpha = .74$), construction of knowledge (e.g., "If I have difficulty understanding a particular topic, I consult other books of my own accord"; 9 items; $\alpha = .72$), use of knowledge (e.g., "The things I learn have to be useful for solving practical problems"; 6 items; $\alpha = .75$) and stimulating education (e.g., "The course team should encourage me to compare the various theories that are dealt with in a course"; 8 items; $\alpha = .86$). Learning conceptions items are scored, ranging from (1) 'I completely disagree' to (5) 'I completely agree'.

Students' learning strategies consist of regulation and processing strategies. To map regulation strategies, three scales were used: self-regulation (e.g., "To test my learning progress. I try to answer questions about the subject matter which I make up myself"; 11 items; $\alpha = .78$), external regulation (e.g., "I study according to the instructions given in the course materials"; 11 items; $\alpha = .68$) and lack of regulation (e.g., "I notice that it is difficult for me to determine whether I have mastered the subject matter sufficiently"; 6 items; $\alpha = .72$). Three main scales and five subscales representing different qualities in processing strategies are used. Deep processing strategies are questioned by means of the subscales relating and structuring (e.g., "I try to combine the subjects that are dealt with separately in a course into one whole"; 7 items; $\alpha = .81$) and critical processing (e.g., "I try to understand the interpretations of experts in a critical way"; 4 items; $\alpha = .67$). Surface processing strategies are questioned by means of the subscales

memorising (e.g., "I memorise lists of characteristics of a certain phenomenon"; 5 items; $\alpha = .73$) and analysing (e.g., "I analyse the different parts of a theory step by step"; 6 items, $\alpha = .67$). One main scale is used to investigate students' use of concrete processing strategies when learning (e.g., "I pay particular attention to those parts of the course that have practical utility"; 5 items; $\alpha = .68$). All items are scored, ranging from 1 (I never or hardly ever do this) to 5 (I (almost) always do this). Cronbach alpha reliability coefficients for the ILS scales measuring learning conceptions and learning strategies were between .66 and .86, which is in line with other ILS-studies (see also Vermunt & Vermetten, 2004).

2.3. Plan of analysis

Since the data in this study are clustered (students into 8 study programmes), preliminary analyses were carried out to determine whether scores on learning pattern scales varied significantly between programmes. Firstly, multi-level null models on the ILS scales revealed no significant differences between programmes. Secondly, to test whether evolution in learning pattern differed between programmes, ANCOVA's on the measurement at the third time point for each of the scales were calculated with programme as a factor and the measurement at the first time point as a covariate. Only for the change in the ILS scale 'stimulating education', significant differences between study programmes were found (F(7.284) = 2.73, p < .01). Based upon these preliminary analyses we decided to use One-way Repeated-Measures Analyses of Variance (ANOVA) to be conducted on subsample 1 to test hypotheses 1 and 2. Afterwards, paired-samples t-test were carried out to examine in which time interval changes on ILS scale scores took place (also on subsample 1). To investigate the third hypothesis, learning patterns were generated by means of cluster analysis on the complete sample (N = 1.039). Subsequently, paired-samples *t*-tests on the ILS scale scores were carried out to examine changes within the different learning patterns (on subsample 2).

3. Results

3.1. Variability in student learning

To examine whether student learning changes over time, ANOVA's with the ILS scale scores as dependent variables and time as the factor were conducted on subsample 1. Significant time effects (Wilk's λ) were found on 11 out of 15 ILS scales (Table 1). The results show that not only learning strategies but also learning conceptions are subject to change which is in line with our first hypothesis. Moreover, the findings also generally confirm the second hypothesis: across time students score higher on learning conceptions and strategies characteristic of more meaning oriented learning. In addition, we found a decrease on scales measuring learning conceptions and learning strategies which are characteristic for reproduction oriented and unregulated learning. The results of the paired-samples t-tests indicate that there was little change in ILS scale means between the first and second year of study, most significant changes occur after two years of study.

3.2. Variability within learning patterns

In a first step we examined whether there were groups of learners with homogenous learning patterns among first-year students on the complete sample. A cluster analysis (Ward, 1963) was carried out on the basis of 10 main ILS scales relating to the following learning pattern components: learning conceptions, regulation strategies and processing strategies. On the basis of the distance coefficients, the explained variance in ILS scores and the way in which clusters could be interpreted a three group clustering was chosen: students with a meaning oriented (16.2%), reproductive/undirected (46.3%) and flexible learning pattern (37.5%). Preliminary analysis shows that the students who participated

² Social work, communication sciences, journalism, electro-mechanics, hotel management, office management, business management and teacher education.

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Results of one-way repeated-measures ANOVA and paired-samples t-test.

ILS scales	1st year	2nd year	3rd year	Wilk's λ	1st vs. 2nd year	2nd vs. 3rd year	1st vs. 3rd year
Processing strategies							
Deep processing							
Relating and structuring	3.22 (.76)	3.27 (.76)	3.37 (.79)	.95**	-	**	**
Critical processing	2.60 (.78)	2.69 (.79)	2.79 (.83)	.94***	-	*	***
Stepwise processing							
Memorising	3.28 (.85)	3.21 (.82)	3.14 (.89)	.97*	-	-	**
Analysing	3.02 (.69)	3.05 (.69)	3.01 (.72)	-	-	-	-
Concrete processing	3.14 (.72)	3.20 (.71)	3.35 (.68)	.90***	-	***	***
Regulation strategies							
Self-regulation	2.57 (.63)	2.59 (.65)	2.72 (.68)	.92***	-	***	***
External regulation	3.29 (.59)	3.21 (.56)	3.12 (.61)	.92***	*	**	***
Lack of regulation	2.50 (.73)	2.36 (.68)	2.24 (.73)	.89***	**	**	***
Learning conceptions							
Intake of knowledge	3.69 (.62)	3.55 (.56)	3.40 (.62)	.80***	***	***	***
Construction of knowledge	3.43 (.53)	3.40 (.54)	3.51 (.55)	.95**	-	**	*
Use of knowledge	4.08 (.57)	4.03 (.51)	4.06 (.55)	-	-	-	-
Stimulating education	3.28 (.78)	3.10 (.71)	3.09 (.77)	.95**	**	-	**

N = 254, Significance level: p < .001 = ***; p < .01 = **; p < .05 = *; - = not significant.

in the three waves of data collection form a representative subset of those entering higher education: 15% belonged to the meaning oriented group, 46% and 39% were characterised by a reproductive/undirected and flexible learning pattern respectively.

These learning patterns are comparable with former cluster results on ILS scales in higher education. The 'meaning oriented' and 'reproductive/undirected' learning pattern corresponds to the 'surface/undirected' and 'deep' cluster identified by Vermetten, Vermunt and Vermetten (2004). The 'flexible' learning pattern, combining deep and surface learning activities, corresponds to the 'flexible/versatile' cluster found in previous research (Donche & Van Petegem, 2009).

To test the third hypothesis, whether students with a different learning pattern upon entry into higher education show a different evolution in learning, we conducted paired sample t-tests for each of the three learning pattern clusters using subsample 2 (N=280). Effect sizes (Cohen's *d*) fluctuate between .17 and .82. A *d* = .2 is indicative of a small effect, while *d* = .5 and *d* = .8 represent a medium and large effect respectively (Cohen, 1988). Results of t-tests within learning pattern clusters show that some learning patterns are more subject to change than others (Table 2).

First-year students exhibiting a reproductive/undirected learning pattern diminish their reliance on undirected learning pattern

characteristics such as a decrease in lack of regulation (M=2.25, SD=.75, t(131)=2.41, p<.05) and conceptualising learning as primarily the intake of knowledge (M=3.45, SD=.57, t(131)=5.77, p<.001). An increase is noted in the more meaning oriented learning pattern characteristics, such as the use of deep and concrete processing strategies (M=3.04, SD=.65, t(131)=-5.57, p<.001) and self-regulation strategies (M=2.44, SD=.61, t(131)=-5.64, p<.001).

First-year students with a flexible learning pattern appear to learn in a more meaning oriented manner in the third year. This can be deduced from small to medium effect sizes found on ILS scales measuring reproductive and undirected learning pattern characteristics. The results show an important decrease of average scores on conceptualising learning as primarily the intake of knowledge (M=3.50, SD=.58, t(108)=7.59, p<.001) and stimulating education (M=3.38, SD=.78, t(108)=4.53, p<.001). In addition, a significant decrease of average scores was found on scales measuring external regulation (M=3.28, SD=.56, t(108)=3.90, p<.001) and lack of regulation (M=2.33, SD=.76, t(108)=5.92, p<.001).

Students who had already acquired a meaning oriented learning pattern in the first year of University College appear to develop this learning pattern further. This can be mainly deduced from small to

Table 2

Results of paired *t*-tests on ILS-scales within the meaning oriented (N=41), flexible (N=108) and reproductive/undirected (N=131) learning pattern cluster.

ILS-scales	Meaning oriented			Flexible			Reproductive/undirected					
	1st year	3rd year	t (41)	d	1st year	3rd year	t (108)	d	1st year	3 rd year	t (131)	d
Processing strategies												
Deep processing												
Relating and structuring	3.51 (.52)	3.63 (.78)	-1.06		3.69 (.63)	3.68 (.77)	.18		2.77 (.64)	3.05 (.68)	-4.44^{***}	.44
Critical processing	2.99 (.70)	2.92 (.77)	.60		2.93 (.73)	3.07 (.82)	-1.99^{*}	.19	2.20 (.67)	2.52 (.74)	-4.59^{***}	.50
Stepwise processing												
Memorising	2.87 (.99)	2.80 (1.02)	.54		3.51 (.78)	3.28 (.94)	3.05**	.29	3.23 (.83)	3.16 (.80)	.90	
Analysing	2.95 (.67)	2.86 (.72)	.80		3.29 (.59)	3.21 (.63)	1.48		2.88 (.70)	2.96 (.77)	-1.29	
Concrete processing	3.57 (.61)	3.56 (.58)	.09		3.60 (.52)	3.63 (.58)	56		2.70 (.57)	3.04 (.65)	- 5.57***	.60
Regulation strategies												
Self-regulation	2.68 (.47)	2.86 (.61)	-2.04^{*}	.38	3.01 (.54	3.03 (.62)	49		2.16 (.50)	2.44 (.61)	- 5.64***	.56
External regulation	3.20 (.51)	3.02 (.72)	1.96(*)	.35	3.48 (.48)	3.28 (.56)	3.90***	.42	3.12 (.61)	3.02 (.60)	1.88(*)	.17
Lack of regulation	2.12 (.66)	1.96 (.59)	1.56		2.76 (.77)	2.33 (.76)	5.92***	.56	2.40 (.54)	2.25 (.75)	2.41*	.28
Learning concentions												
Intake of knowledge	3 13 (58)	3.08 (64)	52		3 92 (51)	3 50 (58)	7 59***	82	374 (55)	3 45 (57)	5 77***	53
Construction of knowledge	3 42 (39)	3 58 (51)	-1.91(*)	41	3 75 (43)	3 75 (46)	02	.02	3 19 (49)	3 34 (54)	- 3 72***	31
Lise of knowledge	3.98 (55)	3.99 (58)	- 07		4 34 (38)	4 25 (48)	1.76		3.94 (57)	3.95 (58)	- 29	.51
Stimulating education	2.55 (.69)	2.77 (.86)	- 1.49		3.72 (.54)	3.38 (.78)	4.53***	.63	3.21 (.76)	3.07 (.71)	1.87	

Significance level: *p*<.001 = ***; *p*<.01 = **; *p*<.05 = *; -.- = not significant.

medium effects sizes found on meaning oriented learning scales. We found a further increase of average ILS scores on self-regulation (M=2.86, SD=.61, t(41)=-2.04, p<.05) as well as for the learning conception construction of knowledge (M=3.58, SD=.51, t(41)=-1.91, p<.05).

The results of *t*-tests within learning pattern clusters also show that some learning characteristics are rather stable. In particular, no significant changes on the level of stepwise processing strategies such as analysing and the learning conception use of knowledge were noted.

4. Conclusion and discussion

The research findings demonstrated that learning patterns during University College can be subject to change. Longitudinal results indicate that first-year students learn in a more undirected manner than third-year students. In general, third-year students appear to exhibit more characteristics of meaning oriented or deep learners which is to some extent in line with former research in higher education (Busato et al., 1998; Donche & Van Petegem, 2009; Severiens, Ten Dam & Van Hout Wolters, 2001; Vermetten et al., 1999; Vermunt & Minnaert, 2003; Watkins & Hattie, 1981). This change, however, seems to occur quite slowly: even in the final year reproduction oriented learning continues to play a crucial role. The increase of meaning oriented learning strategies accompanied by a moderate use of reproduction oriented learning strategies may point to the fact that students during time have adopted more flexible learning strategies. Senior students may also have advanced in their capacity to judge which strategies are more suited to the demands of particular tasks which can also refer to the concept of 'strategic learning' (Entwistle, 1998). In particular, combining meaning oriented and reproduction oriented learning characteristics seems to be a fruitful way to cope in University College. As former research has indicated that constraints like heavy workload are linked to surface approaches to learning (Entwistle et al., 2003), it remains unclear if this aspect or other individual characteristics played an influencing role in the relative development of learning patterns.

The results indicated that the developmental trends differ according to the learning patterns which students have already acquired in the first-year of their study programme. A meaning oriented learning pattern seems to be a more stable pattern in comparison to the reproductive undirected learning pattern. This may also reflect that students who are already more meaning oriented learners in the first year have a learning pattern which enables successful passing in higher education. Students with a more reproductive and undirected learning pattern at the start of their study programme undergo important changes at the level of their learning pattern during their study path, especially during the second and third year of their study.

In this study we could empirically confirm the three above stated hypotheses that were drawn from both previous theory and research. The results indicated that developmental trends in learning patterns are present though large scale research on this topic is still needed to further validate these findings. Moreover, more empirical investigation of a developmental hypothesis regarding to students' learning patterns in higher education contexts is needed. In this study we provided first evidence that when learning patterns are measured at three crucial points of time in a three year University College programme with equal intervals of 12 months, some learning patterns are more subject to change than others. It is far too simplifying to infer from our findings that the development of learning patterns can be conceptualised as consecutive, suggesting that the development of learning patterns takes place in a gradual, phased manner from reproductive/undirected (phase 1) to more flexible learning (phase 2) and thereafter to more meaning oriented learning (phase 3). Future research should consider the investigation of possible transitional phases in learning pattern development using more than three measure moments across time (Bijleveld, van der Kamp & Moojiaart, 1998) and attempt to clarify whether this differs across educational contexts.

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