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Stability of processing and regulation strategies: Two longitudinal studies on student learning

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Abstract. The way students approach their study tasks is often assumed to be dependent on the learning context. This assumption has received little research attention in terms of longitudinal, or within-subjects, designs. In the present article, two longitudinal studies are described which investigate the extent to which learning strategies change. The 'strategy' part of the Inventory of Learning Styles of Vermunt and Van Rijswijk (1988) was used to measure the way students learn. Repeated measures analyses show a number of statistically significant trends. The article concludes by comparing the two studies, and by suggesting future research directions.

Keywords: adult secondary education, learning strategies, longitudinal research, tertiary engineering education

1. Introduction

Whether the way students learn is stable or subject to change has been debated in the past 10 to 15 years. The answer to this question usually differs depending on the specific learning theory or learning construct one is referring to. Curry's so-called onion model (1983) categorizes these different learning theories. Cognitive or learning styles are usually considered to be close to personality and relatively stable; they are therefore conceptualized in the inner layer of the onion (Severiens and Ten Dam 1994), as shown in Figure 1. Learning strategies are concepts which are conceptualized in the outer layer of the onion model. In this layer, the educational context is supposed to highly influence the way students learn. Other researchers have described a similar difference between styles and strategies and the stability of each. Messick (1996) states that styles are more stable and relatively pervasive across areas, whereas strategies are more amenable to change (p. 639). In an educational era in which 'learning to learn' plays an important role, the extent to which the context influences learning strategies is an inter-

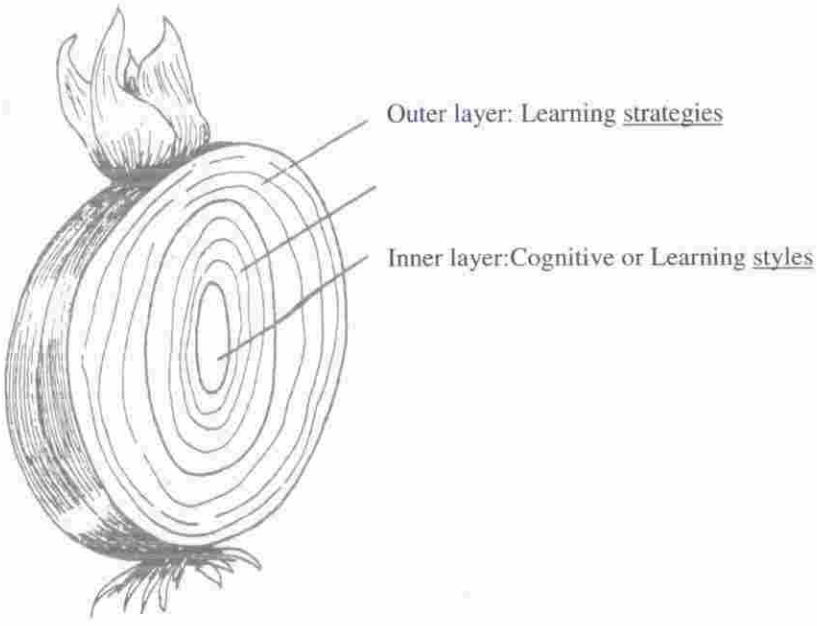

Figure 1. Curry's onion model (1983).

esting question. The answer contains possible consequences for educational practice.

A number of studies have investigated the effect of the contextual features by comparing students across different situations. Discipline, for example, is an important contextual feature (Wolters and Pintrich 1998), assessment procedures show an effect on the way students learn (Vermunt 1992) and teachers, approaches to teaching and task demands also affect the way students approach learning (Schellings and Van Hout Wolters 1995; Trigwell, Prosser and Waterhouse 1999). Not many studies, however, have examined student learning in a time perspective (see also Volet et al. 1994). Longitudinal studies are quite rare. A search in the databases of ERIC, SSCI and the online contents resulted in four studies published in refereed journals (see Table 1). The search was aimed at studies belonging to the outer layer of Curry's onion model (1983). In other words, studies which assign an important role to the learning context. Before the results are discussed, let us comment on the methods used in the four longitudinal studies.

All studies use standardised self-report questionnaires, consisting of Likert-type items which describe different learning behaviours of students. It concerns the Approaches to Studying Inventory (ASI) of Ramsden and Entwistle (1981), a short version of Biggs? Study Process Questionnaire (SPQ) (1987), the Inventory of Learning Styles (ILS) of Vermunt (1992),

and a scale measuring the research oriented learning style (Dippelhofer-Stiem 1989). This last questionnaire measures one orientation, the first three measure different learning orientations. In case of the ASI and SPQ it concerns the deep, surface and achieving orientation, in case of the ILS it concerns the meaning directed (comparable to the deep approach), the reproduction directed (comparable to the surface approach), the application-directed and the undirected learning style. Despite the use of the term 'style' and its supposed reference to the inner layers of the onion model, in Dippelhofer-Stiem's as well as in Vermunt's case, the way learning style is conceptualised indicates an important role of the educational context. Because of this, we discuss the two studies using these two instruments as well.

The psychometric properties of each of these questionnaires is sufficient if not satisfactory. The ASI, SPQ and ILS are validated in different samples: they generally show constant factor structures, and reliability measures and stability coefficients are sufficient in each of these studies. In case of the ASI, external validity is examined by conducting 60 interviews with students scoring either high on the deep approach or high on the surface approach. The interviewers could generally indicate succesfully whether students were deep or surface learners. Factor analyses confirm uni-dimensionality of Dippelhofer-Stiem's 'research oriented learning Style' questionnaire, and also in this case, the reliability and consistency coefficients are satisfactory. We will now continue with describing each particular study. Table 1 summarises the description.

Watkins and Hattie (1981) compared 244 first and third-year tertiary students in the Arts, Science and Economics departments. A number of changes are found. An overall decrease is observed in the meaning orientation, despite the increase in one of its subscales ('inter-relating ideas'). There is also an overall decrease in the subscales measuring the 'reproduction orientation'. Furthermore, students show more negative attitudes toward studying in their third year, they score higher on comprehension learning and lower on globetrotting. Watkins and Hattie conclude that there is 'little evidence that these students' approaches to learning improved (i.e. became deeper) ...' (p. 139). They explain this finding by suggesting that deep-level learning is not needed in order to graduate at this university. This suggestion seems to be confirmed by a low correlation between grades and the meaning orientation, as well as by student comments in interviews.

In the longitudinal study on the research-oriented learning style by Dippelhofer-Stiem (1989), a total of 1301 university students in five European countries in the departments of Arts, Science and Business and Economics were interviewed three times at two-year intervals. An increase in research-

oriented learning is observed in four of the five countries from the first to the ninth semester. However, Dippelhofer-Stiem interprets the increase as 'not great'. Therefore, she wonders whether 'such a level is sufficient for an academic training and for coping with the requirements of the university' (p. 494). Explanations are given at the institutional as well as individual level. It is argued that deep level learning increases as soon as departments stop emphasising factual knowledge, when there is less emphasis on achievement and more on communication and when more opportunities are offered for students to participate in the research process. At the individual level Dippelhofer-Stiem explains that deep level learning is fostered by intrinsic motivation. Therefore, the institutes should enforce 'intrinsic learning incentives, more autonomy for the student, better chances for reflecting on science' (p. 501).

Volet et al. (1994) investigate cross-cultural differences in a longitudinal perspective. Their samples consists of 434 local and 120 South East Asian students attending a first year Introduction to Economics class. Changes in learning approaches of undergraduate students are observed within the period of one semester. The means of the deep and achieving approaches are lower at the end compared to the beginning of the first semester, in the local Australian group as well as in the south-east Asian group of students. These changes are explained in terms of adaptations to course requirements.

Busato et al. (1998) conducted a longitudinal study in tertiary education. A group of 32 psychology students are examined in their second and third year (approximately one year interval), and a group of 26 students are examined twice in their third year (half year interval), and again in their fourth year (approximately one year interval). The mean scores of the meaning- and application-directed learning style increase whereas the mean scores of both the reproduction-directed and the so-called undirected style (which indicates having problems with study strategies) decrease.

All studies described conceptualize learning as dependent on features in the educational context. The results, however, seem to vary in each study. This variation concerns the time interval in which a change is measured (or the magnitude of change) as well as the content and direction of change. In terms of content, some studies observe an increase in deep learning, whereas others do not or even observe a decrease in deep learning. The design of the present study is based on the presented review of longitudinal research on student learning. Changes in learning are investigated in further detail, in two ways.

First of all, our research is conducted in two educational settings which have not been investigated before. The first study is conducted in adult secondary education, the second in tertiary technical education. Adult

Table 1. The four longitudinal studies on student learning summarised

Authors	instrument	Departments Country	Time intervals and year	Results: statistical significant changes
Watkins and Hattie 1985	ASI	Arts, Science and Economics Australia	two years 1st, 3rd year	decrease deep decrease surface
Busato et al. 1998	ILS	Psychology Netherlands	one year, half a year 2st, 3rd, 4th year (longitudinal)	increase deep increase application decrease surface decrease undirected
Volet et al. 1994	SPQ Australia	Economics 1st year	one semester decrease achieving	decrease deep
Dippelhofer-Stiem 1989	Research oriented learning style	Arts, Science and Economics 5 European countries	2 years 1st, 3rd, 5th year	increase deep

secondary education offers a second opportunity to students who did not graduate in regular secondary education[1]. Most students follow a number of different courses, such as Dutch, history, biology, etc. In order to graduate, these students need to obtain certificates in at least six subjects. In tertiary technical education students are educated for all technical professions. The departments of mechanical engineering and constructional architecture were chosen to participate in the present study. Both departments are relatively large and different in their content. By choosing these two departments, it may be possible to draw conclusions on higher technical education in general.

The second aspect of our design which will add to knowledge on longitudinal processes in student learning, concerns the time interval. The described studies have examined student learning on a yearly basis, once a half year interval was used and once longitudinal changes concerned one semester (see Table 2). The studies described in the present article have examined students several times in a period of one school year, twice in the adult education study (half year interval) and three times in the tertiary technical education study (intervals of three months).

Vermunt's ILS is used to investigate the way students learn. Vermunt (1996; Vermunt and Van Rijswijk 1988) conceptualizes learning styles in a broad sense; according to his definition learning styles consist of four aspects: processing strategies (how does a student go about studying), regulation

Table 2. The learning styles and scales of the Inventory of Learning Style (based on Vermunt and Van Rijswijk 1988 and personal communication)

Processing strategies	
Deep processing	Relating parts of the subject matter to each other and to pre-knowledge, structuring into a whole Processing critically of parts of course contents; selecting views, main ideas, conclusions etc.
Stepwise processing:	Selecting facts, concepts, details, definitions, etc., repeating and rehearsing subject matter Step-by-step analyzing of separate parts of course contents
Concrete Processing	Concretising and personalising course content by relating them to own experiences and by using them outside the study context; selecting practically useful contents
Regulation strategies	
Self-regulation:	Regulating one's own learning process through the regulation activities orientating, planning, monitoring, testing, diagnosing, repairing, evaluating and reflecting
External regulation	Letting own learning process be regulated by an external source. Let oneself be directed by the learning goals, study directions, questions, etc. of the course team
Lack of regulation	Monitoring difficulties with the regulation of one's own study processes.

strategies (what does the student do to keep studying), learning orientation (what is the reason for studying) and learning conception (what is the students' personal definition of learning). These aspects collectively form students' learning styles. In the present research, only the processing and regulation strategies will be examined because we intend to complement the picture of stability of learning in the outer layer of the onion model. The concepts of learning conceptions and learning orientations are considered to be relatively stable and therefore, they do not belong to the outer layer of Curry's onion model. Table 2 shows the meaning of each processing and regulation strategy.

Vermunt's theory on learning styles connects to a group of student learning theories which all use the deep versus surface dimension as described by Marton and Säljö (1976a, b). Other researchers belonging to this group are Entwistle (1981), Schmeck (1983) and Biggs (1987). The stepwise processing strategies and external regulation strategies represent the 'surface side' of the dimension. The 'deep side' is represented by the deep processing

strategies and self-regulation. Apart from the strategies indicating deep and surface learning, Vermunt includes a scale for concrete processing strategies and a regulation scale which indicates having problems with learning (undirected learning). The present study uses Vermunt's theory in stead of one of the others from the group of theories mentioned above, mainly because his theory was developed within a Dutch educational context (open university) and because his questionnaire is written in the Dutch language. Given the fact that the empirical part of this study was going to be conducted in the Dutch educational system, we considered this to be an important advantage.

Even though one can question the external validity of learning styles questionnaires such as the ILS, because of three reasons we consider a self-report questionnaire to be an appropriate research method for the purpose of the present article. Firstly, Garcia and Pintrich (1996) argue that, from a constructivist point of view, tapping students own perceptions of learning may be more valid in predicting future behaviour, compared to the more 'objective' research methods, such as observation of learning. A study is described in which it is shown that perception of own behaviour is more strongly related to future behaviour than observation of behaviour. Secondly, the relative ease of administering questionnaires to large samples of students, and the possibilities it offers for generalising results, is another advantage of self-report questionnaires. Thirdly, all other research on longitudinal learning processes uses self-report questionnaires as well. This makes it possible to compare results and build on each others findings.

Before describing stability in the use of strategies, we start out by describing the learning strategies used in these educational settings. Given the fact that little research on student learning is conducted in these settings, a description of the way students learn in our two educational settings seems appropriate. At this point the research questions can be formulated as follows:

1. Which processing and regulation strategies do students use in adult secondary education and in tertiary technical education?
2. Does the use of these strategies change in the course of one school year?

2. Methods

Respondent

Five different schools of adult secondary education participated in our study, which makes up a sample of 191 respondents. All students are in one of the three pre-college years. There are 120 women and 71 men. These students completed the questionnaire twice with a half year interval (November and May of the school year 1994–1995).

Table 3. Reliabilities (Cronbach's alphas) of the ILS scales at each point in time in the two studies

	number of items	adult education		technical education		
		time 1	time 2	time 1	time 2	time 3
Processing strategies						
Deep processing	11	0.81	0.87	0.81	0.80	0.84
Stepwise processing:	11	0.79	0.83	0.73	0.74	0.82
Concrete Processing	5	0.71	0.77	0.65	0.65	0.74
Regulation strategies						
Self-regulation:	11	0.83	0.81	0.76	0.79	0.85
External regulation	11	0.75	0.78	0.61	0.68	0.74
Lack of regulation	6	0.66	0.71	0.68	0.69	0.76

271 students of five different tertiary technical colleges in the Netherlands answered the 60 ILS items three times with intervals of three months (November, February and May 1997–1998). The respondents are all first-year students from two different disciplines: constructional architecture (59%) and mechanical engineering (41%). The group contains 11% female students.

Materials

The 'processing and regulation stategies' part of the Inventory of Learning Styles (ILS) is used (Vermunt and Van Rijswijk 1988) in both studies. The questionnaire was constructed on the basis of a phenomenographical study (see Vermunt 1996). Three scales measure the processing strategies and three scales the regulation strategies (see Table 2).

Since Vermunt and Van Rijswijk's research in 1988, many studies have used the theory and the ILS. The ILS was developed in the settings of higher education and open university (Vermunt 1992), but also adapted for regular secondary education (Roosendaal and Vermunt 1996). The internal consistency of the scales of this instrument is quite acceptable, Cronbach's alpha varies from 0.70 to 0.95 (Vermunt and Van Rijswijk 1988). The alpha's in the present two studies are shown in Table 3, the stability coefficients in Table 4. Both sets of coefficients can be considered as satisfactory, except for the stability coefficient regarding undirected regulation strategies (in the adult education sample r = 0.38) and in the technical education sample ($r_{time1-time2}$ = 0.51). On the basis of these poor stability coefficients, we decided to not consider results regarding undirected regulation. Whether or not factor struc-

Table 4. Stability coefficients (Pearson's Correlations)

	adult education	technical education		
	time 1–time 2	time 1–time 2	time 1–time 3	time 2–time 3
Processing strategies				
Deep processing	0.62	0.72	0.71	0.79
Stepwise processing:	0.66	0.66	0.68	0.81
Concrete Processing	0.60	0.66	0.68	0.75
Regulation strategies				
Self-regulation:	0.63	0.64	0.65	0.74
External regulation	0.62	0.61	0.61	0.73
Lack of regulation	0.38	0.51	0.64	0.74

tures in the ILS are invariant is not an issue, as we do not use factor scores but subscale scores of the processing and regulation strategies only.

Procedure

In the adult education study, the questionnaires were filled out in the classroom under supervision of the researchers. The technical students completed the questionnaires during a lecture under supervision of their teachers.[2]

Analyses

Repeated measures analyses were used to answer the research questions. The scores on the six ILS-scales are analysed as dependent variables.

In the tertiary technical study, we used the data of students who participated at least twice. Of some students data was available of the first and second time points (N = 104), some participated the first and third time (N = 52), and some students the second and third time (N = 18). The number of students who participated three times was 97. The main reason for this relatively large number of students who participated only twice is that lectures are generally not obligatory and thus not attended by all students. It seems a loss to leave out the technical students who participated twice and conduct the analyses on the group of 97 students who participated three times. Roth (1994) suggests that a good and conservative way to deal with such a missing data problem is by imputing the average of the two known scores. In our case, this means that the third score of students who participated twice, is the average score of the two times they did participate. In the 'Roth' imputation

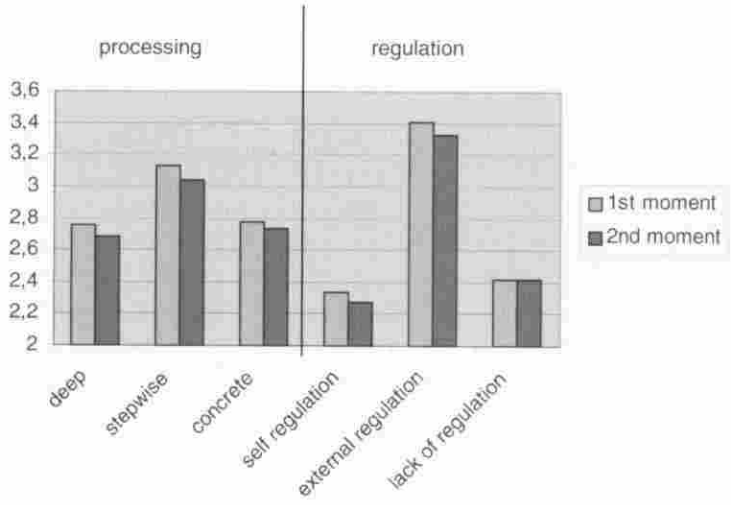

Figure 2. Mean scores on the ILS scales in the adult education group, at the first and second moment (N = 191). The numbers on the vertical ax refer to the Likert scale, 1 'do not agree at all' to 5 'agree completely'.

method the available information is used more efficiently: information on two data points of 174 students is not left out. Because of this important advantage we decided to use this method, which resulted in an N of 271 (see also note 3).

Information of all the adult education students is available of the two points in time (N = 191).

3. Results of the adult education study

Figure 2 shows the scores of the adult education students at the beginning and the end of the school year. We will first describe the mean scores of the scales at each point in time to answer the first research question. Whether or not the mean score of each scale differs from the other scales will also be described. The second question will be answered by describing the significant longitudinal trends and differences ($p < 0.050$) between beginning and end of the school year.

Processing strategies

The means on each scale at each point in time are depicted in Figure 2. Pairwise comparisons were performed to describe mean differences between scales. The t-tests show that at the beginning of the year students use the

stepwise strategies more often compared to the deep strategies ($t(189) = 6.43$, $p < 0.00$) and also more often compared to the concrete strategies ($t(189) = 4.97$, $p < 0.00$). No differences are observed between the deep and concrete strategies. At the end of the school year, the same differences still exist.

Concerning the difference between the beginning and the end of the school year, one trend effect turns out be statistically significant. Students use stepwise processing strategies ($F(1,189) = 2.17$, $p < 0.05$) to a lesser extent at the end of the year than at the beginning. The mean scores on deep and concrete procesing strategies do not change.

Regulation strategies

Pairwise t-tests show that, at the beginning of the year, students more often rely on external regulation compared to self-regulation ($t(189) = 16.11$, $p < 0.00$) (see Figure 2). Besides, the scores on external regulation are higher compared to lack of regulation ($t(189) = 14.02$, $p < 0.00$). The scores on self-regulation and lack of regulation do not differ from each other. At the end of the year, students still score higher on external regulation compared to self-regulation and lack of regulation. But the difference between self-regulation and lack of regulation has also become statistically significant. Students now score higher on lack of regulation compared to self-regulation ($t = 2.02$, $p < 0.05$). This difference seems to be caused by a small (non significant) decrease in self-regulation.

One longitudinal trend is significant: The scores on external regulation ($F(1,189) = 4.21$, $p < 0.05$) are lower at the end of the year than at the beginning. The scores on self-regulation strategies do not change significantly.

4. Results of the tertiary technical education study

In Figure 3, students' scores on each of the learning scales are depicted, on the three different time points.

Processing strategies

Pairwise analyses show that at the beginning of the study year students more often use stepwise than deep processing ($t(270) = 2.34$, $p < 0.05$). Halfway, these means do not differ from each other, but at the end of the study year the difference switches and students more often use deep processing strategies ($t(271) = 1.99$, $p < 0.05$). The means on concrete processing are higher compared to the means on stepwise and deep processing, with one exception. At the beginning of the year students use stepwise and concrete strategies to the same extent.

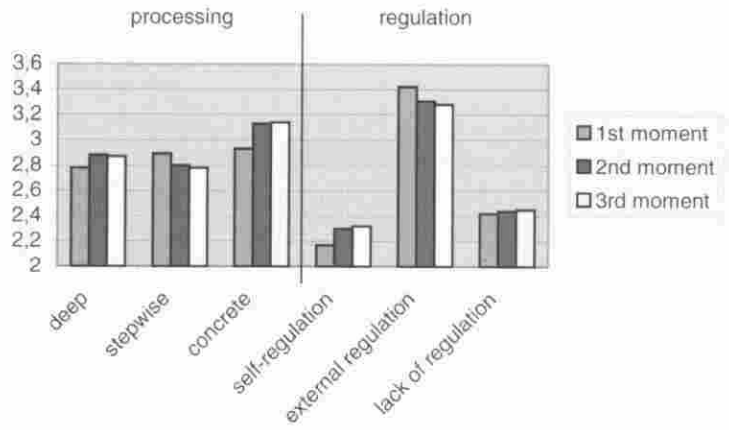

Figure 3. Mean scores on the ILS scales in the tertiary technical education group, at the first, second and third moment (N = 271). The numbers on the vertical ax refer to the Likert scale, 1 'do not agree at all' to 5 'agree completely'.

All three kinds of processing strategies show significant general trends. At the beginning of the school year respondents score higher on stepwise processing than at the end of the school year ($F(2,526) = 9.89$, $p < 0.00$). An opposite effect can be observed for the deep processing scale ($F(2,528) = 6.00$, $p < 0.00$): at the end students more often use these deep strategies than at the beginning. A third significant general trend concerns the use of concrete processing ($F(2,526) = 19.55$, $p < 0.00$). Students more often use concrete processing strategies at the end than at the beginning of the study year.

Regulation strategies

Pairwise comparisons show that throughout the year students more often use external regulation than self-regulation (at time 1, $t(270) = 27.96$, $p < 0.00$, at time 2, $t(270) = 21.20$, $p < 0.00$, at time 3, $t(270) = 18.89$, $p < 0.00$). The scores on external regulation are also higher than those on lack of regulation (at time 1, $t(270) = 19.64$, $p < 0.00$, at time 2, $t(270) = 16.79$, $p < 0.00$, at time 3, $t(270) = 15.13$, $p < 0.00$). Finally, the scores on lack of regulation are higher than self-regulation at all three points in time (at time 1, $t(270) = 5.27$, $p < 0.00$, at time 2, $t(270) = 2.97$, $p < 0.00$, at time 3, $t(270) = 1.84$, $p < 0.00$).

Two of the three regulation strategies show significant longitudinal trends. In the course of the school year, the use of external regulation decreases ($F(2,526) = 11.77$, $p < 0.01$) and the use of self-regulation increases ($F(2,526) = 10.52$, $p < 0.01$).[3]

5. Conclusions and discussion

This article describes two studies which investigate changes in the way students learn within one school year. Not many studies on student learning have used longitudinal 'within-subjects' designs. This lack of research seems contradictory to the fact that learning strategies are often assumed to vary according to context. The need for more longitudinal studies, already asked for in 1985 by Watkins and Hattie, seems obvious. The present study attempts to take a step towards accommodating this need.

In general, the results of the two studies show that learning strategies do change in the context of one school year. In this section, we will first answer the two research questions by comparing the results of both studies.

The first research question asked for a description of the way students learn in adult education and tertiary technical education. First, we will describe the results concerning the processing strategies, and secondly, the results on the regulation strategies. The adult education students generally employ the stepwise strategies more often than the deep and concrete strategies. This is true at the beginning as well as at the end of the school year. The tertiary technical students, on the other hand, can be typified as concrete learners. They more often use concrete strategies than stepwise and deep strategies throughout the school year.

The pairwise comparisons of the regulation strategies show that students score higher on external regulation than self-regulation. This is true in both studies. It means that in both educational contexts and throughout the year, students more strongly rely on external sources, such as teachers and study material, than on themselves. Even though the score on external regulation becomes a little lower at the end of the year, and the score on self-regulation a little higher in case of the technical students, external regulation remains by far the regulation most often used. It seems to be difficult for students to make their own decisions, plan ahead, monitor their own learning processes and tackle their study in their own way. A possible explanation is that the educational context offers explicit regulation in stead of inviting the students to regulate themselves. A parallel interview study in the technical education context, conducted in the same period with the same students, seems to confirm this explanation. This study has shown that teachers pay virtually no explicit attention to fostering processing or regulation strategies (Severiens and Ten Dam 1999).

The second research question focuses on longitudinal changes in learning. Both studies indicate a decrease in stepwise strategies and in external regulation. At the end of the school year, it seems that students do not learn as much step by step, nor memorize as much as at the beginning. Besides, they do not need the teacher to tell them what to do as much as in the beginning.

Neither development is difficult to interpret. After spending a year at school, or at college, students have learned something about what is expected of them ('perception of task demands'; Jetton and Alexander 1997). They rely less on the teacher or on clues in the learning material and 'memorizing' as a learning strategy seems to be less necessary. In short, our two studies show a decrease in surface learning. The opposite trend, an increase of deep learning, only occurs in the tertiary educational setting. In our description of the available research, some variation in results was found as to the development towards deep learning. Our study shows that this development seems to occur in tertiary education but not in secondary education.

The study in tertiary technical education shows more changes than the study in adult education. This difference may be explained by the fact that our first-year technical students have just experienced a large transition in their educational careers. Going from secondary to tertiary technical education requires more change than going from regular secondary education to adult secondary education (see note 1). The technical students may find that their new educational surroundings require a set of learning strategies different from the strategies employed in secondary education. They attune their learning to their task demands (Butler and Winne 1995; Schellings et al. 1996). A qualitative study into student motives to use certain strategies while going from secondary to tertiary education may shed more light on these findings.

The results of the two longitudinal studies have been interpreted in terms of changes in learning. The question can be raised however, whether the observed differences concern stable changes in learning or whether specific situations may have caused the students to (temporarily) change their learning and regulation strategies. If students, for example, fill out the questionnaire immediately prior to an examination, their answers may be different from usual. Two reasons can be given which suggest that the changes we observed really do indicate stable changes in student learning, in stead of accidental changes caused by specific learning contexts. The first reason concerns the fact that each of the two studies is based on a sample drawn in five different institutes. The average learner in this study is, in other words, consitituted in a diversity of contexts, and thus our conclusions exceed the specific learning contexts. The second reason is that the items in the questionnaire do not refer to specific learning situations; they invite students to reflect on their learning behaviour in general.

We will conclude this article by suggesting a few research directions on the basis of the results of the present study. We have already mentioned the need to investigate students? motives for employing a particular set of strategies while going from secondary to tertiary education. The research

done by Pintrich and his co-workers (see e.g. Pintrich and De Groot 1990) may provide a good starting point for this line of research. Secondly, we want to recommend different methods of investigating learning strategies. Recently, Boekaerts (1997) has made a renewed plea for the so-called process-oriented approach into investigating learning. In this approach both beliefs and strategies are investigated while students are learning (Boekaerts 1997, p. 31). The way learners react in different educational situations can be examined, for example, by considering different tasks or different kinds of assessment (Van Hout Wolters 2000). Methods of instruction, types of learning tasks and test demands are important contextual aspects in determining how students learn (Miller et al. 1992). The extent to which students, for example, 'adapt' their strategy use in particular learning tasks may uncover (in)stability of learning strategies in a more detailed way.

Notes

1. The majority of these students are around the age of 19 and can be considered to be 'drop-outs' from regular education. They have failed, for whatever reasons, to pass their exams and they try again in adult education. A minority (around 45 years of age) consists of mostly female students who have not had the chance to study earlier on in life, and go to adult school mainly for reasons of personal fulfilment. The smallest group consists of students who are around the age of 30 and who have decided to change career directions.
2. In the adult education study, some students preferred (and were allowed) to complete the questionnaire at home. Post-hoc analyses showed that this group does not differ from the group completing the questionnaire at school. In the tertiary technical education study, the students who were not present were asked to fill out the questionnaire in their free time, but this alternative procedure was not succesful in terms of response.
3. The analyses on a reduced sample with no missing values (only those students participating three times, $N = 97$) show the same results: the changes in the '97' sample are similar to the changes as observed in the '271' sample. The only difference concerns the decrease in stepwise processing: in the '97' sample the decrease is (just) not statistically significant ($F(2,192) = 2.77$, $p = 0.07$). This means that the conclusions of the article would remain the same, if we would use the '97' sample.

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