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Dissonance in students' regulation of learning processes

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In this article, dissonance in students' way of learning is explored from a regulation of learning perspective. First, consonant patterns of interrelations among learning elements are sketched. These patterns were identified in studies with university students by means of a diagnostic instrument, the Inventory of Learning Styles (ILS), that assesses four learning components: cognitive processing strategies, metacognitive regulation strategies, mental models of learning, and learning orientations. Consonant patterns of linkages among these components result in four qualitatively different ways of learning or learning styles: undirected, reproduction-directed, meaning-directed and application-directed learning. Next, several studies that used the ILS as a research instrument were examined for indications of dissonant patterns of interrelations among these learning components. The students in these studies ranged from early secondary school to adult university students. Five phenomena of dissonance could be identified: lack of differentiation within learning components, lack of integration between learning components, incompatibility of learning strategies, models and orientations, missing learning style elements, and a lack of distinct application-directed learning. These phenomena are described and documented. Finally, the results are discussed in relation to other recent studies on dissonant study orchestrations and in terms of their practical meaning. A developmental explanation for the occurrence of some manifestations of dissonance is offered.

Introduction

Meyer (1991, this issue) uses the term 'study orchestration' to denote patterns of contextualised learning engagement, i.e., learning intentions, motives, and processes, that are

sensitive to students' conceptions of learning. A study orchestration might be expected to exhibit a considerable degree of conceptual consonance between students' conceptions of learning and their learning intentions, motives, and processes. Dissonance in study orchestrations means that the expected coherent linkages between learning conceptions, intentions, motives, and processes fail to appear in a recognisable form. It may, for example, be the case that, for a certain group of students, aspects of learning orchestration that are theoretically incongruent with one another are empirically connected (Meyer, 1991, this issue). These dissonant study orchestrations may be associated with student failure.

Vermunt (1992, 1996) uses the term 'learning style' to denote a coherent whole of learning activities that students usually employ, their learning orientation, and their mental model of learning, a whole that is characteristic of them at a certain period. In this sense learning style is a coordinating concept in which the interrelations between cognitive, affective and regulative learning activities, mental models of learning, and learning orientations are united. While regulative learning activities refer to the more dynamic, on-line aspects of metacognition, a mental model of learning refers to the more static aspect of metacognition (e.g., Flavell, 1987): a student's coherent system of conceptions of learning and associated phenomena. Learning orientations refer to the whole domain of personal goals, intentions, attitudes, worries and doubts of students in relation to their studies (Gibbs, Morgan, & Taylor, 1984). Learning strategies are combinations of learning activities that students use to learn. Vermunt (1996) stresses that, in his view, learning style is not conceived of as an unchangeable personality attribute, but as the result of the interplay between personal and contextual factors. In his research on higher education students, he could identify four such learning styles: reproduction-directed, meaning-directed, application-directed, and undirected learning (Vermunt, 1996, 1998). The focus in this conceptualisation of learning style is on the metacognitive or regulative aspects of student learning.

Apparently, 'study orchestration' as defined by Meyer and 'learning style' as conceptualised by Vermunt share some commonalities. The most important one is that both concepts refer to underlying dimensions defined by the relationships among learning elements like learning activities and processes, learning intentions, motives and orientations, and learning conceptions or mental models of learning. Both concepts are based on the fact that there are typical, common patterns of interrelationships among these elements that define these underlying dimensions. In terms of learning style as conceptualised above, dissonance then means that these typical patterns of coherent linkages between learning strategies, mental models of learning, and learning orientations fail to appear. Since learning style is viewed here mainly from a regulation-of-learning perspective, from here onward this phenomenon will be referred to as dissonance in students' regulation of learning.

All the articles in this special issue highlight the phenomenon of dissonant study orchestration in higher education from certain theoretical backgrounds and with various research instruments. For example, Meyer (this issue) illustrates the phenomenon with a student learning model of clinical diagnosis. Entwistle, Tait, and McCune (this issue) present atypical patterns of student responses to their approaches to studying inventory. Prosser, Trigwell, Hazel, and Waterhouse (this issue) use Biggs' (1987) Study Process Questionnaire as one of their research instruments to identify a group of students with disintegrated learning experiences. Lindblom-Ylänne and Lonka (this issue) analysed students' dissonant study orchestrations in a qualitative way. Cliff (this issue) presents data from an interview study to illustrate forms of dissonance in student learning.

In the present article, the phenomenon of dissonance is explored from a regulation-of-learning perspective. The conceptualisation of learning style as described above has been operationalised previously in a research instrument, the Inventory of Learning Styles (ILS), that is intended to assess four learning components (compare Pintrich, 1994). These components are: students' use of cognitive processing strategies, their use of metacognitive

regulation strategies, their mental models of learning, and their learning orientations (see Vermunt, 1992, 1998). The central question in this article is what manifestations of dissonance can be observed with respect to the interrelations among these learning components. The exploration is based on several studies that used the ILS as a research instrument, with different groups of students.

Students' regulation of learning processes

The Inventory of Learning Styles is based on phenomenographic analyses of interviews with university students about their way of learning, their ideas about learning, studying and teaching, and their motives, concerns, and personal goals in their studies (Vermunt, 1996). Based on the categories of description that were the result of that phenomenographic study, statements were selected from the interviews that were considered to be characteristic for the various categories. When necessary, the formulations were slightly adapted. These statements were included as items in the inventory. In various studies, the final version of the instrument was constructed, using factor, reliability, item, and test-retest analyses. For a description of this construction process and the psychometric qualities of the instrument, see Vermunt (1998).

The instrument was constructed in the context of a research project on students' regulation of learning processes in higher education. The first results of the research project were reported in a book written in Dutch (Vermunt, 1992). Later on, the results were discussed at international conferences. The analyses were then refined, new analyses were conducted, the theoretical background was elaborated, and the results were reinterpreted from a growing understanding of the data. The results of these endeavours were published in international scientific journals (e.g., Vermunt, 1995, 1996, 1998; Vermunt & Verloop, 1999). From 1992 onward, some Dutch researchers used the ILS in their research studies and published the results (e.g., Beishuizen, Stoutjesdijk, & Van Putten, 1994; Klatter, 1995; Schouwenburg, 1996; Boekaerts, Otten, & Simons, 1997; Busato, Prins, Elshout, & Hamaker, 1998; Vermetten, Vermunt, & Lodewijks, 1999; see below). The same was done by researchers from other countries, for example, in Belgium (Schatteman, Carette, Couder, & Eisendrath, 1997), in Finland (Lonka, 1997), and in Indonesia (Ajisuksmo, 1996). In this article we will examine studies that used the ILS as a research instrument to find indications of dissonance in students' learning. Our purpose is to identify various forms of dissonance.

The final version of the ILS consists of 120 statements that cover four learning components: cognitive processing strategies, metacognitive regulation strategies, mental models of learning, and learning orientations. For the strategy items, students are asked to indicate on a five-point scale the degree to which they use the described learning activities in their studies. The scale varies from (1) I seldom or never do this, to (5) I (almost) always do this. For the items on mental learning models and learning orientations, students are asked to indicate on a five-point scale the degree to which the described views and motives correspond to their own views and motives. Here the scale varies from (1) completely disagree to (5) completely agree. The ILS generates 20 scale variables: five processing strategies, five regulation strategies, five mental models of learning, and five learning orientations. These ILS scales and their content are described in Table 1. In several studies with 795 regular university students and 654 open university students, the internal consistencies of these scales turned out to vary between .48 and .89 for regular university students and between .67 and .93 for open university students. In 33 of the 40 cases, the scales had alphas of .70 or higher (see Vermunt, 1998).

Table 1

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

Parts and scales of the ILS	Description of content
Processing strategies	
Deep processing	
Relating & structuring	Relating elements of the subject matter to each other and to prior knowledge; structuring these elements into a whole.
Critical processing	Forming one's own view on the subjects that are dealt with, drawing one's own conclusions, and being critical of the conclusions drawn by textbook authors and teachers.
Stepwise processing	
Memorising & rehearsing	Learning facts, definitions, lists of characteristics and the like by heart by rehearsing them.
Analysing	Going through the subject matter in a stepwise fashion and studying the separate elements thoroughly, in detail and one by one.
Concrete processing	Concretising and applying subject matter by connecting it to one's own experiences and by using what one learns in a course in practice.
Regulation strategies	
Self-regulation	
Learning process & results	Regulating one's own learning processes through regulation activities like planning learning activities, monitoring progress, diagnosing problems, testing one's results, adjusting, and reflecting.
Learning content	Consulting literature and sources outside the syllabus.
External regulation	
Learning process	Letting one's own learning processes be regulated by external sources, such as introductions, learning objectives, directions, questions or assignments of teachers or textbook authors.
Learning results	Testing one's learning results by external means, such as the tests, assignments, and questions provided.
Lack of regulation	Monitoring difficulties with the regulation of one's own learning processes.
Mental models of learning	
Construction of knowledge	Learning viewed as constructing one's own knowledge and insights. Most learning activities are seen as tasks of students.
Intake of knowledge	Learning viewed as taking in knowledge provided by education through memorising and reproducing; other learning activities are tasks of teachers.
Use of knowledge	Learning viewed as acquiring knowledge that can be used by means of concretising and applying. These activities are seen as tasks of both students and teachers.
Stimulating education	Learning activities are viewed as tasks of students, but teachers and textbook authors should continuously stimulate students to use these activities.
Co-operative learning	Attaching a lot of value to learning in co-operation with fellow students and sharing the tasks of learning with them.
Learning orientations	
Personally interested	Studying out of interest in the course subjects and to develop oneself as a person.
Certificate-oriented	Striving for high study achievements; studying to pass examinations and to obtain certificates, credit points, and a degree.
Self-test-oriented	Studying to test one's own capabilities and to prove to oneself and others that one is able to cope with the demands of higher education.
Vocation-oriented	Studying to acquire professional skill and to obtain a(nother) job.
Ambivalent	A doubtful, uncertain attitude toward the studies, one's own capabilities, the chosen subject area, the type of education, etc.

In Table 2, the factor loadings of ILS scales in a four-factor Oblique solution are presented for these two samples of first-year students (adapted from Vermunt, 1998, p. 162). The patterns of loadings from the two samples are highly similar and are fairly typical for university students in the first years of their studies. The first factor shows high loadings of the relating and structuring, and critical processing strategies, self-regulation of learning processes

and learning contents, construction of knowledge as a mental model of learning, and personal interest as learning orientation. Concrete processing also loads rather high on this factor. This dimension was interpreted as a meaning-directed learning style. The second factor represents a reproduction-directed learning style, with high loadings of the ILS scales memorising and rehearsing, analysing, external regulation of learning processes and learning results, intake of knowledge as mental model of learning, and certificate and self-test-directed learning orientations. The third factor was interpreted as an undirected learning style, with high loadings of lack of regulation, an ambivalent learning orientation, and co-operation and stimulating education as mental models of learning. Finally, the fourth factor represents an application-directed learning style, with high loadings of concrete processing, use of knowledge as mental model of learning, and a vocational learning orientation. Busato et al. (1998) and Schouwenburg (1996) found very similar patterns of loadings of ILS scales in their research on university students in the first years of their studies.

Table 2

Factor loadings (pattern matrices) of ILS scales in a 4-factor oblique solution for Open University (N=654) and Regular University (N=795) students (principal component analysis; loadings >-.25 and <.25 omitted). Adapted from Vermunt, 1998, p. 162

	F1		F2		F3		F4	
ILS-scale	OU	RU	OU	RU	OU	RU	OU	RU
Processing strategies								
Deep processing								
Relating & structuring	.71	.72						
Critical processing	.75	.70						
Stepwise processing								
Memorising & rehearsing			.65	.73				
Analysing	.27		.69	.76				
Concrete processing	.58	.65					.43	.39
Regulation strategies								
Self-regulation								
Learning process & results	.78	.74						
Learning content	.69	.72						
External regulation								
Learning process			.82	.73				
Learning results			.67	.54				
Lack of regulation					.75	.74		
Mental models of learning								
Construction of knowledge	.72	.75						
Intake of knowledge		-.36	.67	.54	.35	.33		
Use of knowledge							.67	.74
Stimulating education					.59	.73		
Co-operative learning					.67	.61		
Learning orientations								
Personally interested	(.24)	.54					-.70	-.25
Certificate-oriented		-.41	.40	.40			.59	.33
Self-test-oriented			.34		.32	.29		
Vocation-oriented							.84	.80
Ambivalent					.73	.65		
Eigen value	3.6	4.3	3.0	3.0	2.4	1.9	2.0	1.3
% explained variance	17.9	21.3	14.9	15.2	11.9	9.6	9.8	6.4
Cumulative %	17.9	21.3	32.8	36.5	44.7	46.1	54.6	52.5

Note. Inter-factor correlations vary from .00 to .11 for OU-students and from -.12 to .24 for RU-students.

The underlying dimensions and the associations between ILS-variables are clearly interpretable from a theoretical point of view. Moreover, they seem to generalise across different universities and types of universities. Therefore, in the remainder of this article, the pattern of loadings shown in Table 2 will be viewed as the 'normal' pattern of relations among learning components. We will explore studies in which deviating patterns of loadings of ILS scales were found to determine whether these patterns can be viewed as indications of dissonance in students' regulation of learning: disintegrated or non-congruent patterns of relationships among learning components.

Phenomena of dissonance in students' regulation of learning processes

In this section, deviant patterns will be identified and discussed. We will show and describe dissonant phenomena that have been found with the ILS. These phenomena are not assumed to be independent of one another, but are described here as different manifestations of some form of dissonance in student learning. It is possible to use various methods of analysis to identify manifestations of dissonance in quantitative data, for example, factor analysis, regression analysis, and cluster analysis (see Meyer, this issue). Since all the studies that we review in this section reported the results of factor analysis (principal components) on their ILS data, we will base our explorations and identifications on these factor analytic results.

Differentiation within learning strategies, mental models of learning, and learning orientations is lacking

Typical of the 'normal' pattern of factor loadings is that the scales within a learning component mostly have high loadings on different factors. For example, within mental models of learning, construction of knowledge has its highest loading on the first factor, the meaning-directed factor, and intake of knowledge loads highest on the second factor, the reproduction-directed factor. Stimulating education and co-operative learning load highest loading on the third, the undirected factor, and use of knowledge on the fourth, the application-directed factor (see Table 2). This points to differentiation within a learning component, in this case, the 'mental models of learning' component. In several studies there was no such differentiation.

Klatter (1995) administered the ILS to a sample of 984 first-year secondary school students (12-13 years of age, in the 7th year of their formal schooling). The ILS items were adapted to the language and context of these students. The factor analysis she did was similar to the analyses previously conducted by Vermunt (1992). Her results are shown in Table 3. Four of the five processing strategies show high loadings on the same factor (factor 1). The same holds for three of the five regulation strategies (factor 2), four mental models of learning (factor 3), and four learning orientations (factor 3). This points to a lack of clear differentiation within the learning components. Boekaerts, Otten, and Simons (1997) found very similar results regarding this lack of differentiation when they administered the ILS to several large samples of students in the first, second, and third year of secondary education. It seems that in their learning, these young students do not distinguish as many learning strategies, models, and orientations as university students generally do. This may be an interesting developmental phenomenon. It may well be that one's development as a learner proceeds along this line of increasing differentiation within learning components.

Table 3

Factor loadings of ILS scales in a 4-factor Varimax solution for first year secondary school students (N=984) (principal component analysis; loadings >-.25 and <.25 omitted). Source: Klatter, 1995, p. 181

ILS-scale	F1	F2	F3	F4
Processing strategies				
Deep processing				
Relating & structuring	.82	.27		
Critical processing	.75			
Stepwise processing				
Memorising & rehearsing	.25	.79		
Analysing	.39	.76		
Concrete processing	.68			
Regulation strategies				
Self-regulation				
Learning process & results	.60	.48		
Learning content	.67	.25		
External regulation				
Learning process		.52		
Learning results		.46	.40	
Lack of regulation				.75
Mental models of learning				
Construction of knowledge	.53	.35	.44	
Intake of knowledge		.45	.57	.34
Use of knowledge	.53		.58	
Stimulating education	.27		.48	.50
Co-operative learning				.62
Learning orientations				
Personally interested	.38		.58	
Certificate-oriented		.34	.65	
Self-test-oriented	.31		.61	
Vocation-oriented			.71	
Ambivalent				.75
% explained variance	37.3	9.1	7.4	6.7
Cumulative %	37.3	46.4	53.9	60.6

Table 4 presents the results of a factor analysis of a subgroup of the regular university students from Table 2. The first-semester exam results of 569 students in this group were available. Table 4 shows the pattern of loadings for the 10% of these students with the lowest mean exam results. These results are strikingly similar to the results of the secondary school students with respect to the differentiation found. In comparison with the normal pattern, we see less differentiation within learning components, but somewhat more than in the data for the secondary school students. This is especially true for processing strategies, and, to a lesser degree, also for mental models of learning and learning orientations. Low achievers show little differentiation in processing strategies: four of the five strategies show their highest loading on the same (first) factor. It seems that in their learning, these low-achieving students do not distinguish as many distinct learning strategies, models, and orientations as university students generally do. Maybe their development as learners, in terms of differentiation within learning components, is behind compared to that of their fellow students.

Table 4

Factor loadings (pattern matrices) of ILS scales in a 4-factor Oblique solution for the 10% regular university students with the lowest mean exam results (N=58) (principal component analysis; loadings >-.25 and <.25 omitted)

ILS-scale	F1	F2	F3	F4
Processing strategies				
Deep processing				
Relating & structuring	.73			
Critical processing	.76			
Stepwise processing				
Memorising & rehearsing	.26	.77		
Analysing	.51	.26	-.36	
Concrete processing	.61	-.33		
Regulation strategies				
Self-regulation				
Learning process & results	.84			
Learning content	.69			
External regulation				
Learning process		.70		
Learning results		.27	.26	.30
Lack of regulation	-.31		.50	
Mental models of learning				
Construction of knowledge	.67			
Intake of knowledge		.66		
Use of knowledge	.42	-.42	.41	
Stimulating education			.66	
Co-operative learning			.62	
Learning orientations				
Personally interested	.38		-.29	
Certificate-oriented		.59		
Self-test-oriented				.72
Vocation-oriented			.28	.73
Ambivalent				-.59
Eigen value	4.4	2.4	1.8	1.5
% explained variance	22.2	12.2	9.2	7.5
Cumulative %	22.2	34.5	43.7	51.2

Note. Inter-factor correlations vary between .00 and -.13.

Integration between learning strategies, mental models of learning, and learning orientations is lacking

Typical of the 'normal' pattern of factor loadings is that each factor, or underlying dimension, is composed of elements of most of the four different learning components. For example, the factor representing the reproduction-directed learning style shows high loadings of scales from all four domains: processing strategies (stepwise), regulation strategies (external regulation), mental models of learning (intake of knowledge), and learning orientations (certificate-oriented and, to a smaller extent, self-test-oriented). The same is true for the meaning-directed factor. The application-directed and undirected factors show high loadings of scales from three of the four domains. Such integration was not found in several studies.

Klatter's study (1995) illustrates this phenomenon well. Learning models and orientations, for example, define the third factor almost exclusively. However, these views on learning and motives for learning seem to have little to do with the learning strategies that students use. The first and second factors are, however, mostly defined by processing and regulation strategies. These results point to a lack of integration between, on the one hand, the learning strategies that students use and, on the other hand, their mental models of learning and learning orientations. In contrast to mature university students, what these young students do to learn seems to be hardly associated with what they think about learning and what they want to achieve with their learning. The study by Boekaerts et al. (1997) shows this lack of integration between learning components even more clearly. A sample of second-year secondary school students in their study showed, with one exception, only loadings of mental learning models and learning orientations on the first two factors, and loadings of only processing and regulation strategies on the third and fourth factor. In the normal pattern, the learning strategies that higher education students use are strongly associated with their views on, and motives for, learning. This does not seem to be the case for young students. Vermetten et al. (1999) found stronger relations between the different domains of the ILS among second-year university students in comparison with first-year students. Maybe this is a second interesting developmental phenomenon, that learning behaviour increasingly comes under the control of the views and motives of the learner.

The sample of low-achieving university students in Table 4 also shows indications of this lack of integration between learning components. Here, especially learning orientations seem to be hardly associated with the other mental learning models and students' use of processing and regulation strategies. This points to the possibility that these low achieving students lag behind their fellow students with regard to the integration of their learning strategy use, learning conception, and learning orientation.

Learning strategies, models, and orientations are incompatible

Beishuizen et al. (1994) asked Psychology students to do a task with a text that was presented on the computer, after these students had completed the ILS. For the data analysis, four groups of students were formed, based on their learning style profile. These groups represented different combinations of processing and regulation strategies. The results showed that students who combined self-regulation with deep processing and students who combined external regulation with stepwise processing achieved good results on this task. These are the combinations of processing and regulation strategies that are most common, as can be seen in, for example, Table 2. But, students who combined external regulation with deep processing, and especially students who combined self-regulation with stepwise processing, performed much worse. This may indicate that some students use different, even incompatible, learning strategies and that this incompatibility is associated with low performance.

Another example of uncommon associations among learning style elements can be found in the study by Vermetten et al. (1999). They found a factor among freshmen university students that seemed to be defined by a mixture of application-directed, meaning-directed, and undirected aspects. The fourth factor among low-achieving university students (Table 4), where the orientations elements of the application-directed, reproduction-directed, and undirected learning dimensions together define one factor, also shows evidence of these uncommon and, at least theoretically, incongruent associations.

Elements of learning styles are missing

An example of missing essential elements of learning styles can be seen in Table 4, where the factor loadings of low-achieving university students are depicted. In the normal pattern, reproduction-directed learning is defined by the use of memorising and analysing processing strategies, external regulation strategies directed at both the steering one's learning process and verifying one's learning results, viewing learning as the intake of externally

provided knowledge, and a learning orientation aimed at earning certificates. In the pattern of the low-achieving students, two of these elements are missing: an analytic processing strategy and an external regulating strategy aimed at verifying one's learning results. The first missing element means that students who learn in this reproductive way process the learning contents through pure memorisation with no thorough analytic elements. The second means that they do not check their learning results with such external aids as the self-tests, questions, and tasks provided in the study materials or by the teachers. It seems that this reproductive dimension is narrowed to a very 'bare' form in this sample of low achievers. Another example in this sample is that undirected learning (the third factor) is not at all associated with an ambivalent learning orientation. While mostly students who experience a lack of regulation in their learning (they realise they have study problems but they cannot think of ways to overcome these problems) develop ambivalent thoughts and feelings about their studies (uncertainty about their study choices, their own capabilities, etc), this association is absent in the sample of low-achievers.

The application-directed learning style is lacking

In the 'normal' pattern of factor loadings, the fourth factor is defined by high loadings of a vocation-directed learning orientation and a learning conception in which much value is attached to using the knowledge one acquires. Concrete processing loads moderately on this factor (Table 2). These aspects together were judged to justify labelling this factor as a distinctive 'application-directed' dimension (Vermunt, 1992, 1998). While this seems to hold for adult students, this dimension did not show up as a separate factor in several studies with younger students. For example, in Klatter's (1995) sample of junior high school students there is no such dimension (see Table 3). A distinctive application-directed dimension or learning style is also missing in Boekaerts et al.'s (1997) junior secondary school samples. Severiens and Ten Dam (1997) did a study on gender differences in learning styles in which they administered the ILS to 432 secondary adult education students, most of whom were between 16 and 22 years of age. In their factor solution, the meaning-directed, reproduction-directed, and undirected learning styles clearly show up as distinctive dimensions, comparable to the pattern as shown in Table 2. Although the fourth (actually third) factor shows high loadings of use of knowledge and vocation-orientedness, which are two aspects of the application-directed factor, there is no loading of concrete processing. Busato et al. (1998) found the same in a study on first-year Psychology students at university. This may mean that the application-directed learning style is relatively late in its development, compared to the other ways of learning. Whether this is due to a more or less autonomous psychological developmental process or to the possibility that many learning environments in which students undergo their development do not foster this application-directed way of learning is still an open question.

In the studies conducted by Severiens and Ten Dam (1997) and Busato et al. (1998) with young adult students, the first signals of the development of the application-directed learning dimension are visible: high loadings of use of knowledge and a vocational learning orientation on a distinctive factor. The third defining element of this dimension, concrete processing, however, shows no loading on this factor in both studies. It seems that in these students' thinking about learning and what they want to achieve with their learning, application-directedness is there as a distinctive dimension, which, however, has no learning strategy element yet. This could mean that the development of this learning style starts with the conception and orientation elements and that only later these views and intentions are put into action with the use of a concrete processing strategy in learning.

Discussion and conclusions

The central question in this article is what phenomena of dissonance can be observed with respect to students' regulation of learning processes. These phenomena were explored by

searching for atypical interrelations among elements of four learning components: students' processing strategies, regulation strategies, mental models of learning, and learning orientations. Normal or consonant patterns are manifested as typical combinations of these elements, combinations which together make up four learning styles identified in previous research (Vermunt, 1992, 1998). In the study here reported, five phenomena of dissonance from this typical pattern could be identified:

(a) Lack of differentiation within learning strategies, mental models of learning, and learning orientations;
(b) Lack of integration between learning strategies, models, and orientations;
(c) Incompatibility of learning strategies, models, and orientations;
(d) Missing learning style elements;
(e) The lack of the application-directed learning style.

These manifestations can be well interpreted and modelled in terms of 'interference' as outlined by Meyer (this issue). As stated above, it is not assumed here that these phenomena are independent of one another. It is, for example, very well possible that lack of differentiation and lack of integration often go together in students and that development as a learner is characterised by a simultaneous increase in both differentiation within, and integration between, learning components.

A lack of differentiation within learning strategies, learning conceptions, and learning orientations (phenomenon a) means that students do not see the difference between various ways of processing learning materials, different ways of regulating one's own learning, different views on learning, and various motives for learning. They may lack the metacognitive knowledge and concepts that represent distinctive forms of learning and views on learning and that make it possible to perceive their own learning in a differentiated way. The results of the study by Prosser et al. (this issue) support this idea. They found that the group of students who exhibited evidence of dissonance scored lowest of all groups on conceptual knowledge of the subject matter. It may well be that this group also has low conceptual knowledge of learning processes in general and of their own studying in particular, i.e., low metacognitive knowledge. Cliff (this issue) found the incapability to reflect on study approaches as one form of dissonance. Since such reflection leads to metacognitive knowledge and understanding, these results are in line with each other. All in all, the results point to the possibility that development as a learner may proceed along this line of progressing differentiation within learning strategies, conceptions, and orientations, and that low-achieving university students may lag behind in this development as compared to their fellow students.

A disintegration between the learning strategies students use and their learning conceptions and orientations (phenomenon b) means that the learning activities students undertake are not in line with their views on learning and their learning motives and goals. Conception, motive, and actions are not congruent. This may mean that students' learning activities are more under control of the learning environment (external regulation of learning) than under control of the learner (self-regulation of learning). Lindblom-Ylänne and Lonka (this issue) also observed this phenomenon in their study on dissonance in high-achieving students, which they interpret as a misfit between the learning strategies the learning environment fosters and the strategies the students themselves want to use, in line with their learning style. In this case, there may be a 'friction' between learning and teaching strategies (Vermunt & Verloop, 1999). Sometimes, these frictions may be constructive in nature, in the sense that they stimulate students to develop more mature learning conceptions and learning practices. However, they also may be destructive in nature, for example, when they force students who view learning as the construction of knowledge to use reproductive learning strategies. According to Lindblom-Ylänne and Lonka (this issue), some of these students may have been in a transitional phase, a process of change in their study practices. Again, this increasing integration between learning conceptions, learning orientations, and the use of learning strategies may represent an important developmental trend, and low-achieving students may lag behind in this development as a learner.

Incompatibility of learning components (phenomenon c) may mean that opposing forces are working within the same students in their adaptation to the learning environment. Beishuizen et al. (1994) showed that some groups of students used incompatible, or conflicting, processing and regulation strategies. There may be conflicting tendencies within the same person to use strategies that do not go together. This may induce considerable stress within the individual, resulting in low performance. Cliff (this issue) showed that theoretically incompatible forms of motivation co-exist in some students, which too may induce internal stress and result in low performance. When students exhibit interrelationships between and among their learning strategies, conceptions, and orientations that deviate heavily from the patterns that are normally observed, this may represent pathology in learning (compare Meyer, this issue).

The phenomenon of missing elements of learning styles (phenomenon d) means that some students learn according to a 'bare' version of the style. They may omit essential elements of it, which leads to low achievement, as was shown in this study with respect to omissions in the reproduction-directed style. It may also point to a developmental phenomenon, as was shown here with respect to the application-directed style.

The lack of a clear, distinct application-directed learning style (phenomenon e) is a phenomenon that is often observed. In most student learning research, this dimension is not recognised as a distinct one, but as an element of meaning-directed learning (e.g., Entwistle et al., this issue). Often, however, these studies are done with first-year students. It seems that this style is relatively late in its development, because this dimension is clearly a separate dimension only in adult or advanced groups of students. Lindblom-Ylänne and Lonka's study (this issue) illustrates well that application-directedness is an important dimension of individual difference among advanced medical students. Vermunt (1998) found the same clear distinct style among a sample of adult open university students. It seems that the distinction between meaning-directed and reproduction-directed learning is the first to emerge in the conceptual development as a learner, and that application-directed learning only later emerges as a separate dimension out of, and distinct from, meaning-directed learning. The first signs of the emergence of application-directed learning as a distinctive dimension come from learning conceptions and learning orientations. At that stage, there are no linkages with learning actions. Only in older and more advanced samples of students do linkages between a vocational learning orientation, a conception of learning that stresses the importance of using the knowledge one acquires, and a consonant learning strategy in the form of concrete processing, clearly take form, representing a full-fledged application-directed learning style.

To conclude, the notion of dissonance adds to our understanding of student failure and opens new possibilities for preventing it. This study showed that there are different phenomena of dissonance in students' regulation of learning processes and student learning styles, and that this dissonance is associated with low achievement and with students' being behind in their development as a learner. For the prevention of student failure, it is important that these different forms of dissonance are recognised in time by teachers and student counsellors, and that appropriate and tailored corrective support is offered to students who exhibit dissonance in their learning. Future research should be aimed at the further identification, documentation, and explanation of these different forms of dissonance, and at the design, implementation, and evaluation of interventions targeted at preventing and solving problems of dissonance. To better understand and document the developmental trends that emerged from this study, longitudinal research in which students are followed in their development as learners for a considerable period of time is indispensable.

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Dans cet article, la dissonance dans la façon d'apprendre chez des étudiants est abordée dans une perspective de régulation de l'apprentissage. Dans un premier temps des patterns concordants de relations entre différents aspects de l'apprentissage furent repérés. Ces patterns ont été identifiés auprès d'étudiants à l'aide de l'Inventory of learning styles (ILS), un instrument qui évalue 4 composantes de l'apprentissage: stratégies de traitement cognitif, stratégies de régulation métacognitive, modèles mentaux de l'apprentissage, et orientations de l'apprentissage. Les patterns d'association entre ces composantes permettent de distinguer quatre types de stratégies d'apprentissage qualitativement différents: Apprentissage sans orientation, orienté vers la reproduction, orienté vers la compréhension et orienté vers l'application. Après quoi, plusieurs études utilisant le ILS comme instrument d'investigation sont passées en revue, à la recherche de patterns dissonant de relations entre ces quatre composantes. Les étudiants ayant servi de sujets dans ces recherches vont du début de l'enseignement secondaire jusqu'à l'enseignement supérieur. Cinq phénomènes de discordance ont pu être identifiés: manque de différenciation entre composantes, manque d'intégration entre composantes, incompatibilité entre stratégies d'apprentissage, modèles et orientations, style d'apprentissage lacunaire, absence d'une composante apprentissage dirigé vers l'application. Ces phénomènes sont décrits et illustrés. Enfin, les résultats sont discutés en relation avec d'autres études récentes sur l'orchestration des dissonances d'étude et du point de vue de leur signification pratique. Les auteurs proposent une explication développementale à certaines manifestations de la dissonance.

Key words: Dissonance; Learning strategies; Learning styles; Self-regulation; Student Learning.

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