British Journal of Educational Psychology (2001), **71**, 203–223 *Printed in Great Britain*
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Task perception as a mediating variable: A contribution to the validation of instructional knowledge

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Background. From the perspective of the cognitive mediational paradigm, we focus in this study on students' conceptions of the relationship between instructional interventions and learning: 'instructional knowledge'.

Aims. Task perception has been investigated as a procedural manifestation of instructional knowledge. Four research questions directed the study: (1) how do students perceive a task; (2) by which structure can the relations between categories of task perception be represented; (3) do students differ in their task perception; and (4) is there a significant relationship between students' task perception and the learning activities they plan and/or execute.

Sample. The sample consisted of 149 university freshmen in educational sciences.

Methods. Students were confronted with a concrete task in a natural setting. Correlations were searched for by phi coefficient. Hierarchical classes analysis was used to search for hierarchical relations and inter-individual differences. Goodman-Kruskal λ was calculated to estimate the association between students' task perception and the learning activities they planned and executed. The questionnaire and the design of the coding systems were first tried out in a pilot study.

Results. Students' task perception can be described in 11 categories. Correlations between those categories were low, but a simple hierarchical structure was discovered. Students can be distinguished according to their task perception into eight groups. Finally, the results indicate a statistically significant association between students' task perception and the learning activities they plan and execute.

Conclusions. The study provides additional evidence to involve 'instructional knowledge' and students' task perception as part of it, as mediating variables in future research.

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Instructional design research is directed towards improving learning and instruction, through building effective and efficient instructional environments (Elen, 1995). In order to realise this, knowledge about the complex relationship between instructional environment and learning results is required. The process-product tradition in research on teaching (Lowyck, 1994; Shulman, 1986; Winne & Marx, 1983) assumes a direct line between instruction and learning results. In other words, instruction fully determines the learning results. This assumption is criticised by the cognitive mediational paradigm which puts forwards both instructional agents (teachers, tutors, designers) and students as (f)actors mediating between instruction and learning results (Biggs, 1999; Doyle, 1977; Winne, 1982). The cognitive mediational paradigm holds that not only students' and teachers' concrete behaviours influence the learning results but that their (meta)cognitive processes and activities are important determinants of both efficacy and efficiency of instruction.

In this study we focus on the mediating role of student variables. From the perspective of instructional design, research into these mediating student variables is still in an early stage of development, with little or no hypotheses-testing studies. Research into student learning, on the other hand, has extensively studied students' approaches to learning/studying, their perceptions of learning context, study orchestration, ... and the relations between them (e.g., Entwistle & Ramsden, 1983; Meyer & Muller, 1990; Trigwell & Prosser, 1991). Though there is as yet no elaborated, empirically tested model of student variables available, nonetheless a wide range of variables (e.g., prior knowledge, (meta)cognitive processes, learning strategies, perception, interpretation, mental effort, motivation; Wittrock, 1986) is assumed to mediate between instruction and learning results. Consequently, learning results are not a mere function of the instructional environment since each student operates as a filter for the possible influence of the environment (e.g., Anderson, 1970; Doyle, 1986; Rothkopf, 1970; Winne, 1982, 1987). This perspective clearly coincides with both a vision of learning as an active, constructive, and purposeful process (De Corte, 1990; Shuell, 1988) and instruction as supporting this new kind of learning (Duffy, Lowyck, & Jonassen, 1993; Elen, 1995).

Instructional knowledge (Elen & Lowyck, 1998), as an aspect of metacognitive knowledge, is focused upon in this study. Metacognitive knowledge pertains to three closely related and partly overlapping fields of knowledge: (a) learning (conceptions about cognitive strategies, control strategies, and motivational strategies); (b) tasks (conceptions about learning task elements and requirements); and (c) environment (instructional or other) in which learning occurs (Elen & Lowyck, 1999). Instructional knowledge belongs to the third field of metacognitive knowledge, namely, environmental knowledge. 'Instructional knowledge' is defined as students' conceptions about the relationship between instructional interventions and learning. 'It refers to knowledge of learners about the way in which instructional features may help or hinder them to learn or to realise (instructional or learning) tasks' (Elen & Lowyck, 1999, p. 149).

Instructional knowledge functions as a frame of reference that influences students' perception of the instructional environment. The perception by students of the instructional environment as a whole, and of the different elements in this environment as well, is conceived of as the result of the interaction between instructional knowledge

(internal variable) and the environment (external variable) (e.g., Ramsden, 1988; Reynolds & Shirey, 1988; Salomon, 1984; Wierstra & Beerends, 1996). Students do not react to the objective or nominal instructional stimuli, as constructed by the designer or teacher (e.g., Doyle, 1977; Rothkopf, 1968), but through perception or interpretation they transform the nominal environmental stimuli (e.g., Anderson, 1989; Entwistle & Tait, 1990; Winne & Marx, 1980, 1983). Entwistle (1991) puts it like this: '... it is the students' perceptions of the learning environment that influence how a student learns, not necessarily the context in itself' (p. 202). Because students' perception of the instructional environment is assumed to be a starting point for further learning processes and activities (and consequently learning results) (Boekaerts & Simons, 1993; Fraser, 1986; Ramsden, 1988), perception is considered to be an important variable in determining the efficacy of the instructional environment. Knowledge of how students perceive their instructional environment and how this process can be influenced is, thus, of utmost importance for optimising instruction through instructional design (Lowyck & Elen, 1994; Schellings, 1997).

If one wants to empirically investigate students' perceptions of the instructional environment, then, the object of that perception needs to be more concretely described. Research has already been undertaken into students' perception of (a) more general characteristics of instruction, (b) a specific element or aspect of the instructional environment and, (c) the function of instruction. (a) Concerning students' perception of general characteristics of instruction, research has included attention to the classroom climate (Mitchell & Chandler, 1993; van der Sijde, 1988), school environment (Cleave-Hogg & Rothman, 1991), classroom environment (Entwistle, 1991; Entwistle, Meyer, & Tait, 1991; Geer, 1993; Trigwell & Prosser, 1991; Waxman & Duschl, 1987). (b) Specific elements or aspects of the instructional environment as objects of perception are dealt with in research into students' perceptions of media or methods used in instruction (e.g., perception of demand characteristics of television or printed texts, Salomon, 1984; perception of interactive videodiscs, Lehman & Brickner, 1995; affective perceptions of a two-way interactive video learning experience, Miller, McKenna, & Ramsey, 1993; perception of benefits of small-group peer collaboration, Stebler & Reusser, 1996) or perceptions of teachers and their behaviour (Blöte, 1995). (c) Finally, research has also included attention to students' perception of the functions of instruction (e.g., perception of feedback in a system of self-regulated learning, Butler & Winne, 1995).

In this study, the focus is on students' perception of the task, as a core element of the instructional environment. A task can be described as a non-deterministic trigger for cognitive activity by the student (e.g., Doyle, 1983). 'Tasks present students with a collection of initial conditions and set a goal, either tacitly or explicitly' (Winne, 1985, p. 806). Task perception is considered to be the 'subjective translation' of objective characteristics and demands of the task. The aim of this study is to explore and validate the concept of 'task perception' as a possibly powerful student variable, mediating between the instructional environment, e.g., a concrete task, and students' learning activities. Since measuring learning results was not possible within the investigation at hand, we focused on planned and executed learning activities assuming that they have a considerable effect on students' learning results (e.g., Vermunt, 1992; Vermunt & Verloop, 1999).

We will analyse the content of students' task perception and describe it with a limited

number of qualitative categories. We will explore the relations between those categories and seek the structure through which they can be represented. To be more precise, is it possible to discern relations (linear or hierarchical) between the different categories of task perception? Moreover, inter-individual differences between students with respect to their task perception will be investigated. Are students perceiving tasks in different ways and/or can we discern groups of students based on their task perception? Finally, we will investigate the relation between students' task perception and the learning activities they plan and execute to accomplish the task. Do students who perceive the task in a similar way also plan and execute the same learning activities?

The concrete research questions in this study are the following: (1) How do students perceive a task? Is it possible to discern a limited number of (qualitative) categories in students' task perception? (2) Through which structure can the relations between categories of task perception be represented? (3) Do students differ in their task perception (inter-individual differences)? (4) Is there a significant relationship between students' task perception and the learning activities they plan and undertake in response to this task?

Method

Because of the relative newness of our research question and since no similar investigations have been located in literature, we first tried out our design in a pilot study. This included the questionnaire (the instrument), as well as the process of designing the coding systems and scoring the students (qualitative processing of the data). Fifty-three students who followed the course 'Educational Technology' at the University of Leuven participated. The outcomes of the pilot study suggested some minor corrections to the instrument. Consequently, the coding systems were used as a guideline in the main investigation.

Data gathering: Instrument

Due to the lack of similar studies with respect to the variable task perception, this study is necessarily descriptive or exploratory. Students were confronted with a concrete, ecologically valid task within a university course ('Construct an essay question concerning the first chapter of the history course'). The task was formulated in general terms with little (external) control with respect to content and sufficient opportunity for variation in task perception as a result of inter-individual differences (Lowyck & Elen, 1994). A written questionnaire is used (see Appendix 1). Before accomplishing the task, students had to describe how they perceived the task and which learning activities they planned (second part of the questionnaire). In the third part of the questionnaire, students had to fill out the learning activities they really executed to accomplish the task, while working on it. Thus, three variables and the relations between them were involved in this study: task perception, planned learning activities and executed learning activities.

Since research on task perception is rare, it was not possible to determine a priori categories for students' answers or to use closed questions or even open questions with precoded answers (e.g., Flower & Mangione, 1990; Moser & Kalton, 1986). Furthermore, because the purpose was to investigate how students spontaneously

perceive a task, the use of a priori categories was not even wanted (Foddy, 1993; Schuman & Presser, 1979). Students' spontaneous task perception could be very different from (Lowyck & Elen, 1994; Schellings, 1997) or even determined by (Clarke, 1994) a priori categories of task perception. The same argument leads to the use of open questions for the planned and executed learning activities.

Data processing: Designing coding systems and categorising students' answers

To answer the question 'how do students perceive a task' (research question 1), we tried to discern (qualitative) categories in students' task perception. Data, i.e., the answers of the respondents with regard to their task perception, were qualitatively analysed. Categories were detected through an iterative analysis: a process of cycling back and forth between the answers of the respondents and emerging categories. Meaningful units, like sentences, parts of sentences and/or words function as units of analysis while constructing the coding system, which consists of a number of categories, their definitions and relations (Miles & Huberman, 1994).

The categories of the variable task perception and the frequency distribution of these categories give an answer to research question 1 (how do students perceive a task). Because research question 4 concerns relations between task perception and planned/executed learning activities, we also had to design coding systems for the variables planned learning activities and executed learning activities. The coding systems for both the planned and executed learning activities are identical and extracted following the same (inductive) method, with the exception of their definitions that are partly based on the categorisation by Vermunt (1992; Vermunt & Verloop, 1999). The content of these categories is presented in Appendix 2.

Using these categories, all questionnaires were coded independently by two researchers. Because the categories of the different coding systems are not mutually exclusive, different categories may apply to the same student. Cohen's kappa (Cohen, 1960) was used as a measure of agreement between the two researchers. Because the categories are not mutually exclusive, kappa was calculated separately for all the categories of each variable. Some categories have rather skewed marginal distributions because the category applies to a lot of students or the reverse, the category applies to only a few students. The coefficient kappa is very sensitive to small differences between raters in skewed marginals. If the marginal distributions differ a little between raters, the maximal attainable kappa is not 1 any more but a lower value. Therefore the interrater reliability is expressed here as a percentage of the maximal attainable interrater reliability given the present marginals (Dunn, 1989). The mean interrater reliability for all categories of task perception is 81.1% (SD = 16.4), for the variable planned learning activities 89.6% (SD = 12.1) and for executed learning activities 94.1% (SD = 6.1). These high percentages suggest a good agreement between the two raters and therefore a satisfactory reliability of the categories for each variable.

Data processing: Phi coefficient, Hiclas and Goodman-Kruskal λ

To discover linear relations between the categories of task perception (research question 2), the phi coefficient (Edwards, 1984) was calculated between all possible pairs of categories as a measure of correlation between variables. The phi coefficient is the equivalent for binary data of the common Pearson correlation coefficient.

Research question 2 is also concerned with hierarchical relations between categories of task perception. Therefore, and taking into account the third research question, we applied a disjunctive hierarchical classes analysis (De Boeck & Rosenberg, 1988; De Boeck, Rosenberg, & Van Mechelen, 1993). The hierarchical classes analysis (Hiclas) constructs a structural model in which classes of equivalent categories and students and their hierarchical relations are represented. Three aspects are involved in a hierarchical classes analysis: (a) classes of equivalent categories or students, (b) hierarchical relations between different equivalence classes, and (c) connection between the hierarchical structure of classes of students with that of classes of categories. Thus, the same method gives an answer to research question 2 (hierarchical relations between the categories) and 3 (inter-individual differences between students with respect to their task perception).

Hiclas constructs a model combining the following three aspects: (a) Students, who perceive the task in a similar way (and for which almost the same categories apply), will be grouped into an equivalence class. Analogously, categories that are applicable to (almost) the same students are grouped into an equivalence class of categories. (b) Different equivalence classes of students and categories are placed in a hierarchical structure. Broader equivalence classes of categories (students), which apply to a larger group of students (for which more categories apply), are placed on a higher level in the category (student) hierarchy. Classes situated on the lowest level of the hierarchy are called basic classes. (c) Moreover, Hiclas connects the hierarchical structures of the students and categories. Basic classes of students are linked to basic classes of categories, since they are applicable to all the classes of categories directly related to that basic class (see Figure 1). From such a linked structure of the two hierarchies, it is easy to derive which categories are applicable to which students and vice versa. An example of the interpretation of a Hiclas analysis will be given in the results section. Students or categories that do not fit in the structural representation belong to the zero class. For a more technical and complete description, see De Boeck and Rosenberg (1988), De Boeck *et al.* (1993).

The same method, disjunctive hierarchical classes analysis, was applied to the data matrices of the variables 'planned learning activities' and 'executed learning activities'. This resulted in two (one for each variable) double structures (one for the categories and one for the students). To find out whether students who perceive the task in a similar way (who belong to the same class in the structure of the task perception variable) are also planning and/or executing similar learning activities (belong to the same class in the other structures) (research question 4), we calculated the Goodman-Kruskal λ (Liebetrau, 1983) as an estimation of the correlation between the classes of students of the different Hiclas solutions. Goodman-Kruskal λ is used to measure the association between nominal variables. We tested whether λ differs significantly from zero, i.e., if there exists an association between the variables task perception, planned and executed learning activities.

Participants

A total of 149 freshmen in educational sciences at the University of Leuven participated in the main investigation. The frequency of female students in educational sciences is much higher than that of male students and this is also represented in this investigation.

Of the participants 136 were female. Twelve students were excluded from further processing of the data because they did not fill out the whole questionnaire. The present analysed sample contains 12 male and 125 female students. Other identification data (previous studies, motivation, and preference for a certain instructional/learning situation) were gathered but are not reported here because they are not relevant to the research questions at hand (see part one of the questionnaire, Appendix 1).

Results

Categories of task perception

We were interested in the way students perceive a task and, more specifically, in the possibility of distinguishing (qualitative) categories in students' task perception (research question 1). The results show a limited amount of categories for the main variable 'task perception': 11 categories were discerned. A description of the content of the categories is presented in Appendix 3. Because the categories are not mutually exclusive, in principle, all categories can apply to each student. About 80% of the students construct their answer from their own perspective and pay attention to deep level processing in concrete terms. The majority of the students focus on the term 'essay question'; 42% of the students describe how they understand the term, whereas 33% explain what a right answer should be to an essay question. More than 50% of the students perceive the task as a whole and they refer to a deep level of processing in abstract terms. Thirty-six per cent of the students perceive the task in terms of learning activities, 22% in terms of requirements or conditions, 19% indicate in their answer the task goal for students and 10% formulate goals for the teacher.

Correlations between categories of task perception

Results show the majority of the correlations between the categories of the variable 'task perception' (research question 2) are centered around zero. Thirty correlations differ significantly from zero ($r(137) = .166$, $p < .05$, two-tailed test). Despite the statistical significance of some correlations, we must conclude that the correlations are low (91% of the correlations are situated between -.04 and .04) and that even the statistically significant ones are not practically significant (.166 is not a substantial correlation). These low correlations may possibly be due to the use of the phi coefficient as measure of association. Phi coefficient is strongly influenced by the proportion of students who score 'one' on a particular category (Edwards, 1984); more specifically, extreme proportions always lead to low values for the phi coefficient. Furthermore, dichotomous variables mostly lead to weaker correlations compared to continuous variables (Nunnally, 1978).

Low correlations do not mean that no other relationships could be found between those categories. The hierarchical relation between two variables (for example: 00001110 and 11111110), for which the correlation is low (for example: .354), can be perfect. From a first exploration, it can be concluded that a linear structure does not give an adequate representation of the relations between the categories. Consequently, a hierarchical classes analysis will be applied to the data.

Hierarchical relations between the categories of task perception

The results of the hierarchical classes analysis will be presented graphically (see Figure 1). The graphical presentation simultaneously contains the hierarchical structure of classes of students and that of classes of categories. The hierarchical structure of classes of categories is turned upside down and placed under the hierarchical structure of classes of students. Students or categories that belong to the same class are grouped and hierarchical relations between classes are represented by arrows, which point to hierarchical lower classes.

The results of the hierarchical classes analysis for the main variable 'task perception' are presented in Figure 1. Hierarchical relations between the categories of the variable 'task perception' (research question 2) can be derived from this figure. Figure 1 has been chosen to represent the hierarchical relations between the categories because it has a satisfactory fit (.734) to the data.

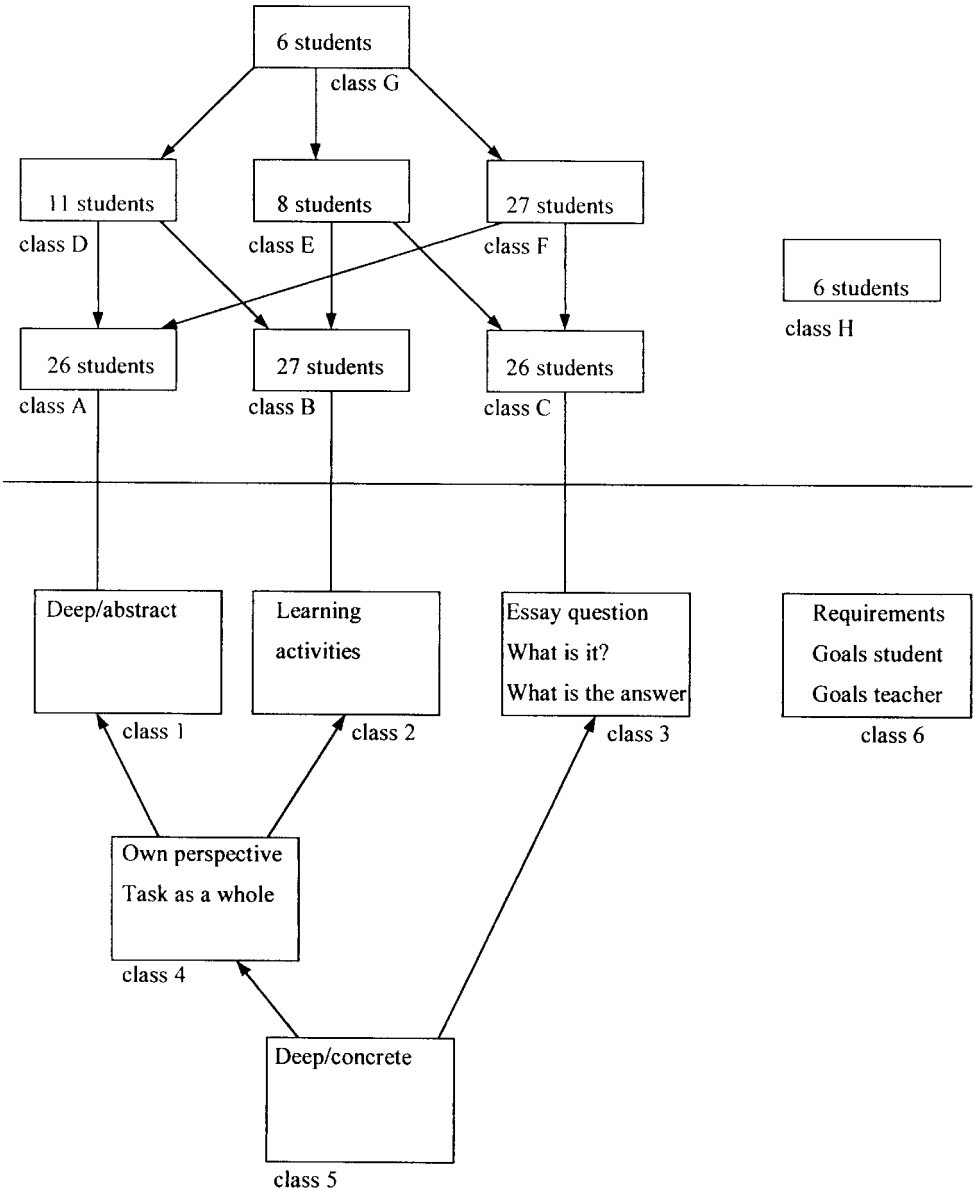
There are six classes of categories located at three hierarchical levels (the bottom half of the figure). The zero class (class 6) contains three categories (requirements, goals for the students and goals for the teachers). The hierarchical relations between the classes of categories can be formulated as three basic patterns or if-then-relations of task perception. These basic patterns can be derived from the figure by following the arrows in the opposite direction starting from a basic class of categories. Three basic patterns were found: (I) If a student's task perception refers to a deep level of processing formulated in abstract terms, then he/she perceives the task from his/her own perspective, looks at the task as a whole, and also refers with concrete terms to deep level processing. (II) If a student perceives a task in terms of learning activities, then he/she perceives the task from his/her own perspective, looks at the task as a whole, and refers with concrete terms to a deep level of processing. (III) If a student's task perception is directed to the specific words of the task, more specifically, if the student describes what an essay question is or what the answer to an essay question should be, then the student is also pointing in his/her answer to a deep level of processing in concrete terms.

These basic patterns representing students' task perception may be interpreted as task perception-styles (ways of perceiving a task), defined as personal dispositions that are manifested partly under the influence of the characteristics of the task (and the rest of the instructional environment). These task perception-styles are particularly interpreted based on the basic classes (lowest classes in the hierarchy) because these classes differentiate in the strongest possible way between task perception-styles. We can, then, interpret those basic patterns as follows: (I) In the first task perception-style the task is immediately linked by students to deep level processing. (II) Students in the second task perception-style focus on the solution of the task, which is perceived as a problem to be solved. In doing so students point in particular to the learning or problem-solving activities they have to undertake. (III) The third task perception-style directs students' attention to the (conceptual) nature of the task. The task is analysed while students search for the meaning of it.

Inter-individual differences between students' task perception

Inter-individual differences between students (research question 3) can also be derived from the hierarchical structure of the variable 'task perception' (see Figure 1). In the

Figure 1. Hierarchical classes-structure for the variable 'task perception'



upper half of the figure, eight classes of students are represented with their mutual relations. The zero class (class H) contains six students while the others are grouped in seven classes spread over three hierarchical levels. In the graphical representation, basic classes of students (class A, class B, and class C) are directly connected with basic classes of categories (respectively class 1, class 2, and class 3). If students are situated in

one of the basic classes (class A, class B, and class C), their task perception consists of the basic pattern that contains the connected basic class of categories. Students belonging to one of the basic classes (class A, class B and class C) thus perceive the task according to the corresponding basic pattern or task perception style (respectively pattern I, II, III). Students belonging to class A, for example, perceive the task from their own perspective, look at it as a whole and refer with concrete and abstract terms to deep level processing, interpreted as a task perception style directed towards deep level processing.

In Figure 1, hierarchically higher classes (classes D, E, F, and G) are connected (by arrows), either directly or indirectly, to two or more basic classes. This means that the task perception of students situated in these classes consists of a combination of the basic patterns of the basic classes to which they are connected. Classes of students do not therefore correspond to just one class of categories (there is no perfect symmetry between the students and the categories with respect to the number of classes and the structure). Classes of students are (via basic classes of students) connected with one or more basic patterns of categories, depending on their place in the hierarchy.

Forty-six students (classes D, E, F) combine two basic patterns (or task perception styles). The combination of basic patterns can be derived from the graphical presentation by following the arrows pointed at hierarchically lower classes of students and read off which basic classes and corresponding basic patterns are linked. Applied to class D, for example, this means that students combine basic patterns I and II. These students refer in their task perception to a deep level of processing in concrete and abstract terms, they perceive the task as a whole, in terms of learning activities, and from their own perspective. The six students of class G combine all three patterns because they are related (see Figure 1) to all three basic classes. Thus, according to their task perception (characterised by one or more basic patterns or task perception style), students can be grouped in eight different classes.

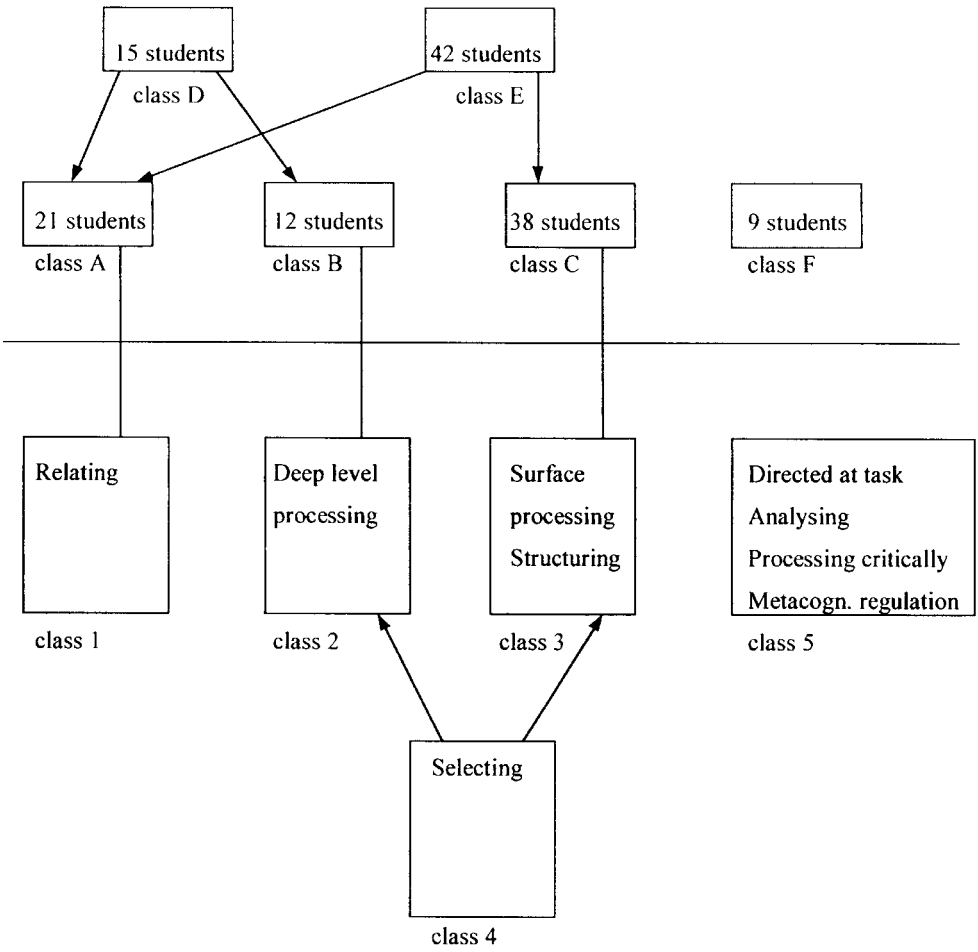
Relation between students' task perception and the learning activities they plan and undertake

We discuss the content of the hierarchical structures (see Figure 2 and Figure 3) of the variables 'planned and executed learning activities' only briefly because this does not give a direct answer to research question 4.

The hierarchical relations between the categories of the variable 'planned learning activities' are represented by the structure in Figure 2. This structure has been chosen because it has a satisfactory fit (.731) to the data. There are five classes of categories including the zero class (class 5) which contains four categories. Students were grouped in six classes with nine students located in the zero class (class F). While elaborating a structure for the data set of the variable 'executed learning activities', we opted for the structure presented in Figure 3 (goodness of fit: .703). This resulted in eight classes of students with 10 students in the zero class (class H) and five classes of categories with four categories situated in the zero class (class 5).

To answer research question 4, especially, the classes of students of all three hierarchical structures are important. We tried to find out whether students who are situated in the same class of students for the variable task perception also belong to the same class of students for the variables planned learning activities and executed learning

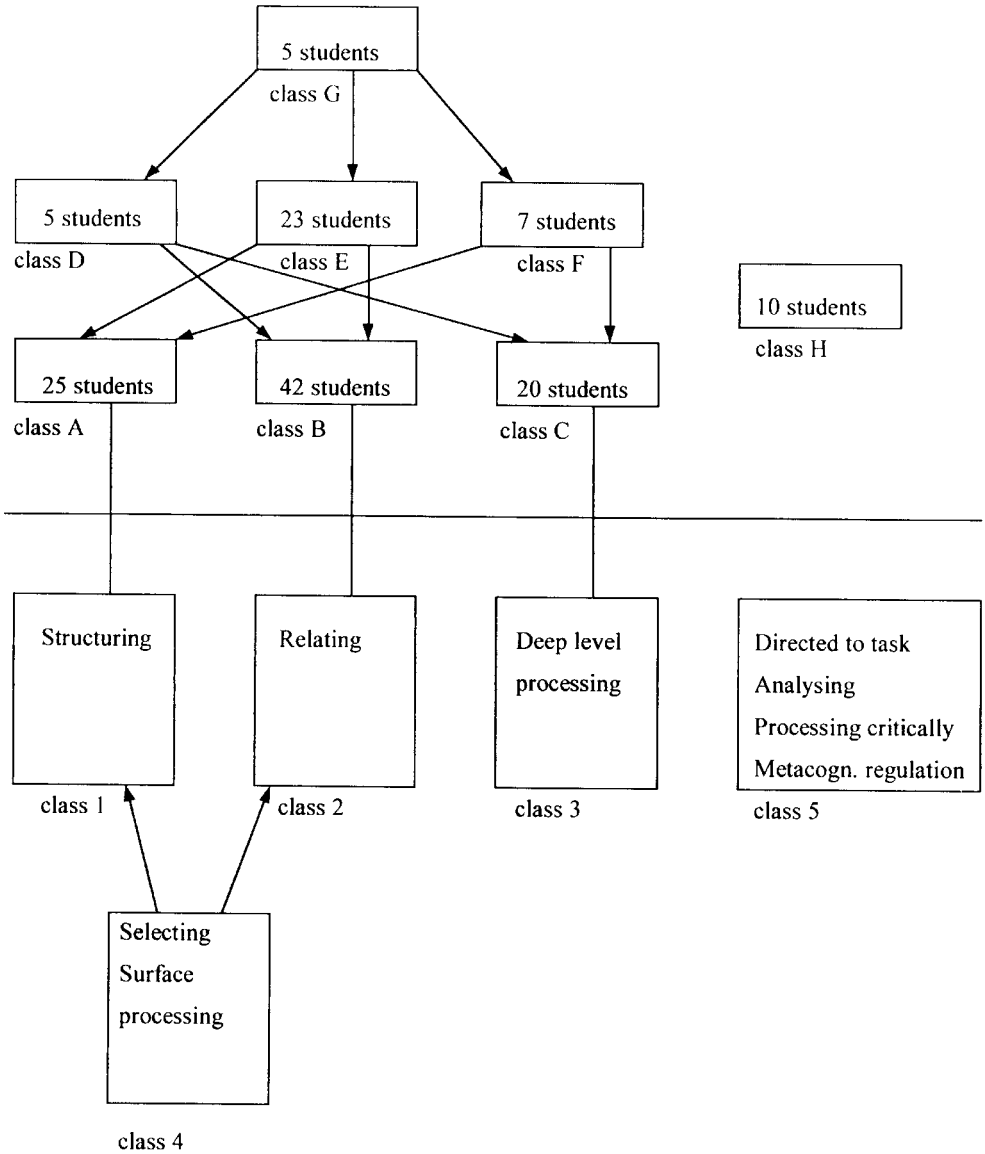
Figure 2. Hierarchical classes-structure for the variable 'planned learning activities'



activities. The estimated λ (measure of association) between task perception and planned learning activities is .673 and the estimation of the variance is .002. This means that the 95% reliability-interval of λ does not contain zero and so the null hypothesis that there is no association between the classes of students of the variable task perception and planned learning activities can be rejected at the $\alpha = .05$ level. There is also a significant relation between task perception and executed learning activities. The estimated λ between these variables is .584 and the estimated variance is .009. These results indicate that students who perceive the task in a similar way also plan and execute similar learning activities.

Table 1 specifies how students' task perception relates to the learning activities they plan and execute. An overview of the concrete relations between the three variables is presented in Table 1 so that only one example will be elaborated here. The 27 students

Figure 3. Hierarchical classes-structure for the variable 'executed learning activities'



who belong to class F for the variable 'task perception', are all planning the same learning activities, i.e., they all belong to class C for the variable 'planned learning activities'. Concerning their executed learning activities, 19 of them belong to class B for the executed learning activities-variable and the other eight are situated in class E.

Table 1. Overview of the specific relations between students' task perception and the learning activities they plan and execute

Planned learning activities variable		**Task perception variable**		**Executed learning activities variable**	
Classes of students and their planned learning activities	Number of students	Classes of students and their task perception	Number of students	Classes of students and their executed learning activities	Number of students
Class F (zero class)	3	Class A Deep abstract, own perspective, task as a whole, deep concrete	26	Class H (zero class)	4
Class A Relating	21			Class A Structuring, selecting, surface processing	22
Class B Deep level processing, selecting	2				
Class C Surface processing, structuring, selecting	10	Class B Learning activities, own perspective, task as a whole, deep concrete	27	Class C Deep level processing	12
Class E Relating, surface processing, structuring, selecting	17			Class E Structuring, relating, selecting, surface processing	15
Class B Deep level processing, selecting	10	Class C Essay question, what is it, what is the answer, deep concrete	26	Class A Structuring, selecting, surface processing	3
Class C Surface processing, structuring, selecting	1				
Class D Deep level processing, selecting, relating	15			Class B Relating, selecting, surface processing	23
Class E Relating, surface processing, structuring, selecting	11	Class D Deep abstract, learning activities, own perspective, task as a whole, deep concrete	11	Class C Deep level processing	8
				Class F Deep level processing, structuring, selecting, surface processing	3
Class E Relating, surface processing, structuring, selecting	8	Class E Learning activities, essay question, what is it, what is the answer, own perspective, task as a whole, deep concrete	8	Class F Deep level processing, structuring, selecting, surface processing	4
				Class D Deep level processing, relating, selecting, surface processing	4
Class C Surface processing, structuring, selecting	27	Class F Deep abstract, essay question, what is it, what is the answer, own perspective, task as a whole, deep concrete	27	Class B Relating, selecting, surface processing	19
				Class E Structuring, relating, selecting, surface processing	8
Class E Relating, surface processing, structuring, selecting	6	Class G Deep abstract, learning activities, essay question, what is it, what is the answer, own perspective, task as a whole, deep concrete	6	Class D Deep level processing, relating, selecting, surface processing	1
				Class G Structuring, relating, deep level processing, selecting, surface processing	5
Class F (zero class)	6	Class H (zero class)	6	Class H (zero class)	6

Discussion

From a perspective of designing and optimising instruction, the aim of this study was to investigate the relation between instructional environmental and learning results through the role of the student as mediator. We focused on the student variable 'instructional knowledge', defined as students' conceptions of the relationship between instructional interventions (e.g., task) and learning. This knowledge functions as a frame of reference for a student's perception of the instructional environment. To investigate students' perception empirically, we choose the task as the core of the instructional environment to be the concrete object. It would be interesting to focus in future research directly on students' instructional knowledge or on the relation between students' perception and their instructional knowledge.

The results of the main investigation reveal the possibility of describing students' task perception with a limited number of qualitative categories (research question 1). The majority of the students interpret the task from their own perspective, referring to deep level processing and looking at the task as a whole. These results support the assumption of the cognitive mediational paradigm (e.g., Winne & Marx, 1983), namely that the same stimulus leads or can lead to different perceptions. This contribution draws attention to students' perception of the task, as a core element of the learning environment, in addition to studies about students' perception of other aspects of the environment (e.g., Entwistle, 1991; Wierstra & Beerends, 1996). Because this investigation is carried out as a first exploration of the content of students' task perception (with a limited number of participants), future research must investigate the consistency of these categories. The use of grounded theory analysis or phenomographic approaches to analyse students' perceptions could be interesting for further research in this topic.

The results show low correlations between the categories of the variable task perception. However, students' task perception can be represented in three basic patterns of hierarchical relations, which are interpreted as three task perception-styles (research question 2). The concept of task perception-style is used here with explicit reference to the influence of the environment, in contrast with the concept 'learning style' as discussed by Entwistle (1991) and Vermetten (1999). Perception, and more generally, the learning process, is defined in this contribution as the result of the interaction between the person and the environment. This concept of 'task perception-style' is meant as a provisional hypothesis open for further research. It would be interesting to investigate the consistency of these task perception-styles across different tasks, the relation with other constructs such as, e.g., learning style. Because of the exploratory nature of this study, no further conclusions with respect to the content of these styles can be drawn.

Concerning research question 3 (inter-individual differences between students), results show that students can be allocated to eight hierarchical groups with respect to their task perception. Each student's task perception can be described using one or more task perception-styles. Different groups of students represent inter-individual differences between students with respect to their task perception. If this result could be replicated in future research, task perception would become a new student variable to be considered for differentiation. This has important consequences for the design of

instructional environments.

In order to answer research questions 2 and 3 we introduced a new research method (Hiclas) which may reveal a substantive structure between categories. Moreover, this method returns a classification of persons that can be linked to the structure in the categories. This study was meant as a first exploration in the use of this method for our research topic. Results show a few of the possibilities of applying the hierarchical classes analysis. It would be interesting to analyse more validated systems of categories with this method.

Finally, the results show that students who perceive the task in similar ways also plan and execute similar learning activities (research question 4). The observation of inter-individual differences and the association between students' perception and their planned and executed learning activities supports the hypothesis that students' perception of the instructional environment represents a potentially powerful variable that should be taken into account when designing instruction (see also Meyer & Muller, 1990).

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Received 8 September 1999; revised version received 16 September 2000

Appendix 1

Questionnaire

Part I: Identification

Part II: Perception and planned (learning) activities in response to the task
In this part of the questionnaire, you do *not* have to accomplish the task yet. We are only interested in your perception of the task and the learning activities you plan to execute.

Task:
Construct an essay question concerning the first chapter of the course

1. How do you perceive this task? What do you think this task is all about? Try to describe it as analytically as possible.
2. What would you add to the task to make it more clear and concrete?
3. Describe concretely the activities you plan to accomplish the task.

Part III: (Learning) activities executed while accomplishing the task
You can only fill in this part of the questionnaire *when you have finished part II*. We ask you not to read or alter your previous answers.
1. Construct an essay question concerning the first chapter of the history course. Write down carefully, while accomplishing the task, what you are doing (concrete activities).

Essay question:

Concrete activities:

Appendix 2

Coding system for the variables 'planned learning activities' and 'executed learning activities'

There are three groups of categories according to the object of the learning activities: A first group refers to learning activities directed at the task, a second group contains categories directed at the processing of the text from the history course, and a third group of categories contains learning activities directed at preparing the result, namely the essay question.

General rule: the categories are not mutually exclusive, so the student can score 'one' in each of them in principle, except if indicated explicitly.

- Directed at the task

(1) *Activities directed at the task:* Students who are referring to activities as 'rereading the task', 'analysing the task', 'profoundly reading the task', score 'one' in this category.

'Looking up the meaning of the word essay question'
'Rereading the task. Checking what exactly is meant by the task'

- Directed at the text of chapter one

To define these categories we used the existing categorisation of Vermunt (1992), and Vermunt and Verloop (1999)

(2) *Relating:* 'Looking for connections between different parts of the subject matter, between the parts and the whole, the broad outline of the learning materials, and new information and prior knowledge or preconceptions'

'Rereading the text and searching for relations'
'Trying to find relationships between the different parts which, in your opinion, represent the heart of the chapter and thus should be included in the essay question'

(3) *Structuring:* 'Bringing together separate parts of information into an organised whole, trying to impose structure on the learning contents, and integrating newly acquired knowledge into the knowledge one already has'

'After reading, drawing a scheme or making a summary of the chapter'
'Representing schematically the main points'

(4) *Analysing:* 'Breaking down a larger whole into the parts of which it is composed, sorting out step by step what different aspects of a problem, line of thought or theory may be discerned'

'Reading the chapter paragraph by paragraph'
'Reading each part separately'

(5) *Processing critically:* 'Thinking along with authors, teachers and fellow students, drawing one's own conclusions based on facts and arguments, rather than just accepting anything that is said or written'

'Looking for the logical classification made by the teacher while drawing up the course and giving an explanation for it'
'Reading over it again more thoroughly (more critically)'

(6) *Selecting:* 'Distinguishing between main and minor points, reducing large amounts of information to the most important parts'

'Indicating or marking important things'
'Noting down key words/names/happenings'

(7) *Metacognitive regulation activities:* 'Those thinking activities students use to decide on learning contents, to exert control over their processing and affective activities and to steer the course and outcomes of their learning'

'Asking questions to myself: Can we distinguish a multitude of paragraphs? Which is the purpose of this chapter in the course?'

- Directed at the result (the essay question)

(8) *Surface processing:* Students score 'one' when they do not enumerate any activity, except processing the text of chapter one, to construct the essay question.

'Afterwards, formulating a question'

(9) *Deep level processing:* Students who not only process the text of chapter one but explicitly refer to activities to prepare the construction of the essay question or to control the quality of the essay question, score one in this category.

'Thinking about what part you will ask a question. Trying to formulate the question as clearly as possible. Rereading the question. Trying to answer the question'
'Formulate an essay question. Examining what could be a possible answer. Verifying in which parts of the text the answer (part of the answer) could be found.'

Rule: Students cannot score 'one' in both categories (8) and (9). Furthermore, when a student does not enumerate any activity after processing the text, then he/she scores 'zero' in both categories (8) and (9).

Appendix 3

Coding system for the variable 'task perception': Categories and their relations

General rule: The categories are not mutually exclusive, so the student can score 'one' in each of them in principle, except if indicated explicitly.

(1) *Essay question:* The student's answer is focused on the term 'essay question'. The student asks himself/herself what this term means and tries to explain its content.

Rule: Students who score 'one' in this category are also scoring 'one' in category (2) and/or (3) because these categories indicate in which way the student is explaining the content of the essay question.

(2) *What is an essay question:* When students focus on the term 'essay question by indicating what an essay question is, or by giving a description or a definition of an essay question, they score 'one' in this category.

> *'Constructing a question which refers to the whole and from which different aspects are included in the text. An overarching question which is not literally written in the text. Not a question asking to reproduce the content matter.'*

(3) *What is the answer to an essay question:* When students mostly describe what the answer to an essay question should be, or the nature of this answer, he/she scores 'one' in this category.

> *'The answer is not literally in the book and should give some freedom to the student (so there is no perfect answer).'*

Rule: Students can score one on both categories (2) and (3).

> *'Formulating a question to think (certainly not just a question asking to reproduce the content matter) in which you refer to different elements from the chapter. In such a way that the one who has to answer the question has to process the whole chapter actively'*

(4) *Task as a whole:* When a student looks at the task as a whole, he/she scores 'one' in this category. The student points to the meaning of the task as a whole, how the task can be executed, the purpose of the task, the requirements or conditions that should be met to fulfil the task.

> *'First, you have to understand the task and comprehend the relationships between the different parts of the chapter. You have to connect the different facts. Then, you can accomplish such a task.'*

Rule: When the student does not explicitly pay attention to the meaning of the term 'essay question', then he/she scores 'one' in category (4). Consequently, the relation between the categories (1) (essay question) and (4) (task as a whole) is not entirely asymmetrical. This means that when the student scores 'one' in the category 'essay question', he/she is mostly scoring 'zero' in the category 'task as a whole', and vice versa. Because the relation is not entirely asymmetrical, it is in principle possible that a student scores 'one' in both categories.

(5) *Own perspective/view:* A student scores 'zero' in this category when he/she is explicitly taking the perspective of the teacher in answering the question. More exactly, when the student takes the place of the teacher in his/her answer, when the student does not describe his/her own perception of the task, but what the designer of the task has put in the task. When the student does not explicitly refer to this external perspective, we assume that the answer represents the student's own opinion and so he/she scores 'one'.

> *'The student is expected to be at work on the course in a creative and active manner. He/she is asked to process the first chapter more deeply and construct a meaningful essay question.'*

(6) *Deep/abstract:* Students score 'one' in this category when they point in their answer to deep level processing. Furthermore, they use vague, abstract terms to refer to this deep level processing.

> *'. . . such a question can be meaningful in the sense that responding means you have processed one part of the subject matter'*
> *'To understand and have insight in the subject matter, and then try to construct such an essay question'*

(7) *Deep/concrete:* When the answer contains information referring to a deep level of processing formulated in concrete terms, then a student scores 'one' on this category.

> *'Searching for a question upon which the answer refers to the whole course and for which it is necessary to connect things'*

> *'The question should be constructed so the answer can not be a literal reproduction of some elements, but one has to try to connect elements with each other, to bring together causes and consequences, to bring different elements together in a coherent whole'*

Rule: Categories (6) and (7) do not exclude each other. A student can refer to a deep level of processing both in abstract and concrete terms. When a student scores 'zero' in both categories (6) and (7), this means that the student is not mentioning a deep level of processing, but he/she only enumerates surface processing activities.

To differentiate between deep level and surface processing activities, we followed the distinction between a deep approach and surface approach to learning of Marton and Säljö (1984). We applied the distinction between a deep and surface approach not only to the learning activities that students describe, but also to the goals of the teacher or student that students are referring to in their perception, to the explanation they give to the term 'essay question', and to the requirements they enumerate.

(8) *Requirements:* Students who score 'one' in this category perceive the task in terms of requirements or conditions to be fulfilled to execute the task.

> *'To be able to accomplish the task, you have to know exactly what is in this first chapter. You have to know the key thought of the chapter'*

(9) *Learning activities:* When a student enumerates learning activities to be done while executing the task, he/she scores 'one' in this category.

> *'Reading the chapter several times. Extracting the important concepts, distinguishing main points and details. Understanding, trying to figure out the meaning.'*

Rule: When these learning activities are formulated as goals for the teacher or student or as requirements, then the student's answer scores 'zero' in category (9) (learning activities) and 'one' respectively in category (11), (10), or (8).

(10) *Goals for the student:* Students who are pointing in their answer to the goal(s) of the task for students score 'one' in this category.

> *'Goal: be able to ask yourself such questions, self-evaluation'*
> *'I think the goal of this task is twofold: namely understanding the text and knowing what is expected by the professor'*

(11) *Goals for the teacher:* When students describe the goal(s) of the task for the student, when they indicate the benefit or the use the teacher can make of the essay questions the students formulate, they score 'one' in this category.

> *'Checking, starting from the constructed essay question, if the student studied the first chapter properly and understood it well. Also to check if a student is able to connect different parts of the course. Are students able to question themselves?'*

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