# Students' goal orientations, information processing strategies and knowledge development in competence-based pre-vocational secondary education



*DOI:*
10.6100/IR652885

*Document status and date:*
Published: 01/01/2010

*Document Version:*
Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

# Students' goal orientations, information processing strategies and knowledge development in competence-based pre-vocational secondary education

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The research reported here was carried out at the

And the

In the context of the research school

(Inter University Centre for Educational Research)



A catalogue record is available from the Eindhoven University of Technology Library
ISBN: 978-90-386-2036-7
NUR: 841

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PROEFSCHRIFT

ter verkrijging van de graad van doctor aan de
Technische Universiteit Eindhoven, op gezag van de
rector magnificus, prof.dr.ir. C.J. van Duijn, voor een
commissie aangewezen door het College voor
Promoties in het openbaar te verdedigen
op donderdag 11 februari 2010 om 16.00 uur

door

Maaike Koopman

geboren te Enschede

Dit proefschrift is goedgekeurd door de promotor:

prof.dr. D. Beijaard

Copromotoren:
dr. P.J. Teune
en
dr. P.J. den Brok

**Contents**

## Acknowledgements

Ruim vier jaar geleden vertrok ik vanuit het hoge Noorden richting Eindhoven om te beginnen met mijn loopbaan als promovendus. Gedurende deze jaren heb ik ontzettend veel geleerd en een leuke tijd gehad. Een aantal mensen wil ik daarvoor bedanken.

Mijn dank gaat allereerst uit naar alle mensen die mij hebben begeleid, namelijk Johan van der Sanden, Peter Teune, Douwe Beijaard, Perry den Brok en Wim Jochems. Zonder hen was dit proefschrift er nooit gekomen. Johan was toen ik begon aan dit project mijn promotor, maar overleed helaas in december 2005. Ik mis zijn inspiratie en enthousiasme voor het vmbo nog dagelijks. Dankzij hem heb ik onderzoek kunnen doen naar dit boeiende onderwerp. Peter, jij was de stabiele factor onder mijn begeleiders. Je ving me op toen ik even geen begeleider had en hebt me geholpen om het onderwerp te verkennen en het onderzoek op poten te zetten. Ik ben je daar heel erg dankbaar voor. Ik ging met veel plezier naar onze overlegmomenten. Ik hoop dan ook dat we in de toekomst blijven discussiëren over het onderwijs en dat ik soms nog een goed advies of een peptalk van je krijg! Wim, bedankt dat je ruim een jaar mijn promotor hebt willen zijn. Je hebt me geholpen om structuur aan te brengen in mijn onderzoeksplannen en je hebt ervoor gezorgd dat het voor "Fontyspromovendi" een stuk makkelijker werd om hun draai te vinden in de wereld van het onderwijsonderzoek. Douwe, ik ben blij dat je de laatste twee jaar mijn promotor bent geweest. Je hebt me enorm geholpen bij het schrijven van mijn artikelen. Het was fijn dat ik altijd bij je terecht kon en dat je met jouw perfectionistische blik naar mijn schrijfsels bleef kijken. Je aanwijzingen en commentaar waren erg leerzaam. Perry, bedankt dat jij het laatste jaar bent aangeschoven in het begeleidingsteam. Ik heb dankzij jou en jouw niet aflatende enthousiasme veel geleerd op het gebied van ingewikkelde statistiek. Ook je kritische blik tijdens het schrijfproces van het proefschrift was een verrijking.

Vervolgens zou ik graag de scholen die deelnamen aan mijn onderzoek willen bedanken voor hun medewerking. Uiteraard gaat mijn dank uit naar alle leerlingen die het mogelijk maakten dat ik inzicht kreeg in hun leren. Docenten en medewerkers van TOP-3C, Innovatieve Techniek, het Midden-Brabant College (Zorg & Welzijn, Techniek en Frater van Gemert), het Prisma van Cooth, het Beatrix College, het Fioretti College, het ROC Tilburg en het Radius College wil ik danken voor het feit dat zij hun school hebben opengesteld en voor de hulp bij al het regelwerk dat onderzoek doen met zich meebrengt. In het bijzonder wil ik Jos Reulen, Kees de Goeij, Koen Giesbers en Barend van de Ven bedanken voor alles dat ze voor me hebben gedaan en voor de prettige samenwerking.

Mijn werkdagen waren een stuk leuker door mijn naaste collega's. Kariene, het was erg fijn om samen met jou aan dit werk te beginnen. Dank je voor alle gezelligheid, maar ook voor je hulp en feedback met betrekking tot dit proefschrift. Evelien, ik ben blij dat ik je "buddymoeder" mag zijn. Dank je voor alle kopjes thee en koekjes. Marieke, ik hoop dat we nog regelmatig samen treinreizen naar Utrecht blijven maken. Ook de andere collega's van ons team van de Pedagogisch Technische Hogeschool zorgden ervoor dat ik met plezier naar mijn werk ging. Bedankt voor de goede werksfeer en al jullie steun.

Ik zou graag de Raad van Bestuur van Fontys, de directie van de Pedagogisch Technische Hogeschool en de Fontys Graduate School willen bedanken voor alles dat ze sinds 2005 hebben geregeld om mensen de kans te geven praktijkgericht onderzoek te doen en te promoveren. Ik heb veel gehad aan mijn medepromovendi en collega's van de Eindhoven School of Education. Met name de mensen van de eerste lichting: Ellen, Geeke, Gijs, Martin, Kariene en Ralph zorgden er in het begin voor dat de toen nog wat provisorische werkplekken door hun aanwezigheid toch gezellig werden. Mijn student-assistenten Anja, Carina, Esther en Peter Paul wil ik bedanken voor het feit dat ze ervoor hebben gezorgd dat alle concept maps snel en nauwkeurig werden geanalyseerd.

Tot slot wil ik ook de mensen in mijn naaste omgeving bedanken voor het feit dat ze er altijd voor me zijn. Mijn vriendinnen wil ik bedanken voor hun interesse, maar ook voor alle leuke en sportieve dingen die we hebben gedaan. Speciale dank gaat uit naar mijn ouders en Jart. Pap, dankzij onze gesprekken durfde ik de stap te nemen om uit het vertrouwde Groningen te vertrekken om dit werk te gaan doen. Dank je voor alle adviezen die je geeft. Mam, je hebt me niet alleen enorm geholpen met het uittypen van interviews maar vooral door je luisterend oor en grote betrokkenheid. Jart, dank je voor alle tijd die je hebt gestopt in de opmaak van tabellen, figuren en dit proefschrift. Bauke, natuurlijk word jij hier ook genoemd. Dankzij jouw aanwezigheid gaat alles de laatste jaren net even makkelijker en is alles nog veel leuker. Dank je voor je liefde en ondersteuning.

# CHAPTER 1

# Introduction

## 1.1 Background to the study

In the Netherlands, the majority of students between 12 and 16 years of age are enrolled in pre-vocational secondary education (PVSE; in Dutch: *voorbereidend middelbaar beroepsonderwijs*). Many PVSE schools have taken the initiative to implement forms of competence-based education during the last decade. The development of competence-based education in these schools has its roots in the need to resolve certain problems with which many PVSE schools are confronted and the need to meet new demands. Among the problems and new societal demands are: (a) low student motivation, early drop-out and high drop-out rates, (b) inadequate alignment between PVSE, further schooling and the labour market, (c) changing demands of the labour market with regard to the abilities of graduates, and (d) societal need for life-long and self-regulated learning (Kuijpers & Meijers, 2009; Ministerie van Onderwijs, Cultuur en Wetenschappen, 2006; Westenberg, Donner, Los, & Veenman, 2009).

In PVSE, the school initiatives related to competence-based education have often been funded by the Dutch government although no policy obliges schools to provide competence-based education. However, post-secondary Vocational Education and Training (VET; in Dutch: *middelbaar beroepsonderwijs*) schools are obliged to provide competence-based education. And given that the purpose of PVSE, among other things, is to prepare students for Vocational Education and Training, a number of PVSE schools have, as already noted, started to implement forms of competence-based education and thereby make an effort to better prepare their students for subsequent VET.

Competence-based education is thought to provide an adequate solution for the problems and new demands mentioned above. Competence-based learning environments are based upon new insights from the fields of learning psychology and educational science (Bransford, Brown, & Cocking, 2000; Oemar Said, 2009; Simons, van der Linden, & Duffy, 2000). The need for competent professionals both now and in the future requires not only knowledge and skills which are fairly simple and often fragmented but also more complex knowledge and abilities such as critical thinking, knowing how to cooperate and general problem-solving skills which typically call for active, self-directed, collaborative and context-based learning (Simons & Bolhuis, 2004). Competence-based education can foster the development of these abilities and types of learning. Competence-based education also calls upon intrinsic motivation and stimulates students to integrate knowledge, skills and attitudes and thereby develop numerous competences.

In the literature, there is some consensus on the characteristics that appear to be critical for competence-based education. Wesselink, Biemans, Mulder, and van der Elsen (2007) have outlined the following principles which provide a framework for competence-based vocational education and training (pp. 45-47):

- The competences, that form the basis of the study program, are defined;
- Vocational core-problems are the organizing unit for (re)designing the curriculum (learning and assessment);
- Competence development of students is assessed before, during and after the learning process;
- Learning activities take place in different authentic situations;
- In learning and assessment processes, knowledge, skills and attitudes are integrated;
- Self-responsibility and (self-)reflection of students are stimulated;
- Teachers both in school and practice fulfil their role as coach and expert in balance;
- A basis is realised for a life-long learning attitude for students.

According to de Bruijn (2007), the foregoing principles can be reduced to four essential characteristics of competence-based education (pp. 3-5), namely:

- Teachers are pivotal in creating powerful learning environments;
- Proven teaching methods are related to experimental ones;
- (Occupational) identity learning is stimulated;
- Self-regulation on the part of students is stimulated.

These characteristics can thus be used to examine the extent to which a given PVSE learning environment can be judged as competence-based.

Competence-based learning environments and the characteristics of these are supposed to promote the development of competences. There are a number of assumptions about the learning processes related to competence-development in these learning environments in PVSE. The adoption of authentic and attractive learning tasks, for example, is supposed to call upon the intrinsic motivation of students and thereby foster the development of competence (Hmelo-Silver, 2004). More specifically, the type of student motivation for learning has been shown to influence their goal orientations, which can range from more intrinsic goal orientations (i.e., mastery) to more extrinsic goal orientations (i.e., performance and work avoidance; see section 1.2.2) (Hmelo-Silver, 2004; Struyven, Dochy, Janssens, & Gielen, 2006). The goal orientations of students are further assumed to be the engine behind their learning and to influence the learning activities they undertake — including the types of information processing strategies they utilize — and their learning results. With regard to the learning activities of students, information processing strategies (cognitive strategies), meta-cognitive strategies and affective strategies can be distinguished (Vermunt, 1992). Competence-based education was created to promote and is focussed on the meta-cognitive and affective learning of students in particular (de Bruijn, 2007; Kicken, Brand-Grüwel, & van Merriënboer, 2008; Vermunt & Vermetten, 2004). Not surprisingly, the focus of most studies in competence-based education thus lies upon these aspects of student learning. Competence-based education is also supposed to elicit deeper cognitive learning processes in which students thus work to structure and relate the content of what is learned, think critically and process learning content in a concrete manner (e.g., think up additional examples, think up examples from outside school; de Corte, 1990; Segers & Dochy, 2001). Such deep learning typically stems from both an intrinsic motivation to learn and intrinsic goal orientations and results in better learning outcomes than surface learning. Finally, learning outcomes in competence-based education are obviously related to the development of competences, but often with an emphasis on the relevant skills and attitudes. Nevertheless, knowledge is necessary to become a competent professional and therefore considered an essential component of competence-based education as well.

Despite the many assumptions made about the learning processes of students in competence-based learning environments, little empirical information is available with regard to the relevant learning processes. This is due — at least in part — to the fact that the concept of competence-based education has been defined to only a limited extent, the available definitions differ widely and most of the definitions have been formulated more from a theoretical than an empirical stance (Wesselink et al., 2007). As a consequence of this situation, considerable differences also exist in the designs of competence-based learning environments (van den Berg & de Bruijn, 2008). The effects of different forms of competence-based education — and particularly competence-based *vocational* education — have received relatively little empirical study. As a result, very little is known about how the characteristics of competence-based education can or should be investigated within the context of PVSE. Whereas a reasonable amount of research has been conducted to date on the learning processes of students in higher education (e.g., Vermetten, Lodewijks, & Vermunt, 2001), the instruments used in such research obviously cannot simply be adopted without alternation to investigate the learning processes of students in PVSE and particularly those in competence-based learning environments. Several (specific) characteristics of students in PVSE must be taken into account (Driessen et al., 2005; Melis, 2003), such as: (1) the reading skills of PVSE students are often limited and many PVSE students therefore find it difficult to read long sentences and/or unfamiliar words, (2) many PVSE students find it very difficult to represent abstract concepts, and (3) the capacity for self-reflection on the part of PVSE students is often limited, which is known to complicate the conduct of research among such learners. Finally, (4) many PVSE students have been found to have rather short attention spans. The aim of the present research was therefore to describe and further explore the relations between the preferred goal orientations of PVSE students, their preferred information processing strategies and the development of their knowledge in competence-based learning environments.

The results of the present research may be of relevance for several reasons. The results may contribute to our knowledge of which instruments are most suited to investigate the goal orientations, information processing strategies and knowledge development of students in PVSE. The results also have the potential to contribute to theory regarding competence-based education and student learning within the context of PVSE. Subsequently, the variables of interest — namely, their goal orientations, information processing strategies and knowledge development — will be measured in different schools with presumably different competence-based learning environments. Finally, the findings should provide suggestions for the design of competence-based PVSE learning environments, how to guide students within such environments and thereby optimize the learning of PVSE students.

## 1.2 Theoretical framework

### 1.2.1 Competence-based learning environments in PVSE

A large part of the PVSE schools in the Netherlands today are implementing characteristics of competence-based education. Student learning in such an environment can be viewed from a social-constructivist perspective (Wesselink et al., 2007). In competence-based learning environments, that is, knowledge must be constructed by the learners on the basis of their experiences (van der Sanden, 2004). Competence-based PVSE schools generally strive to create learning environments in which students must work on complex and challenging learning tasks and thereby develop essential problem-solving skills and collaborative learning skills (de Corte, 2003; Merrill, 2002; Könings, Brand-Grüwel, & van Merriënboer, 2005). In such environments, the manner in which the active construction and integration of knowledge, skills and attitudes is guided appears to be of vital importance (Kirschner, Sweller, & Clark, 2006; van Merriënboer & Paas, 2003).

One of the founding fathers of research on learning environments, Rudolph Moos (1979), distinguished between the *content and organization* aspects of the learning environment and the *interaction* aspects of the environment. In communication and psychology, similar distinctions are made (Watzlawick, Beavin, & Jackson, 1967). In the present research, the characteristics of competence-based learning environments are operationalized using the classification system of de Bruijn et al. (2005), who, in a similar fashion distinguishes between the *content* and *guidance* dimensions of learning environments. The content dimension concerns the manner in which the relevant learning content is dealt with in the learning environment; the guidance dimension concerns the type of guidance provided by teachers for the students, such as coaching and feedback. The advantage of using the dimensions distinguished by de Bruijn et al. (2005) is that they were originally developed to characterize competence-based learning environments within the context of vocational education.

De Bruijn and Overmaat (2002) divided the content dimension of learning environments into the following four components:

(a) the actual subject matter (e.g., authenticity of the subject to be studied, integration of subject areas, tasks which resemble professional practice, learning-to-learn);
(b) the structure and range of the subject matter (e.g., the adoption of competences and authentic situations as the starting point for the learning and practice of knowledge and skills);
(c) the delivery of the subject matter (e.g., the use of a mixture of teaching methods, different sources of information, input from students, interaction with students);
(d) forms of processing the subject matter (e.g., active learning, exploratory learning, reflective learning).

Comparable characteristics can be found in other studies on the design and effects of competence-based learning environments (e.g., Schelfhout, Dochy, Janssens, Struyven, & Gielen, 2006; Sluijsmans, Straetmans, & van Merriënboer, 2008; Wesselink, Biemans, & Mulder, 2007). The guidance dimension of learning environments concerns the types of systematic guidance provided by teachers, experts and peers to foster competence-based learning (e.g., instruction, demonstration, thinking aloud, autonomous student work, provision of active support, coaching, provision of help when necessary, evaluation, feedback) (de Bruijn & Overmaat, 2002). The various types of guidance are all aimed at both the promotion of student learning — frequently using a fixed programme order — and the acquisition of the knowledge, skills and attitudes needed for competence. Comparable forms of guidance have been reported in other studies of the roles of teachers in competence-based learning environments (e.g., Entwistle & Peterson, 2004; van Grinsven & Tillema, 2006; Schelfhout et al., 2006).

De Bruijn et al. (2002, 2005) next translated the content and guidance dimensions of competence-based learning environments into a number of questionnaire items with accompanying scales. The resulting questionnaire was thus used to classify learning environments with respect to how competence-based they were and was therefore also selected for use in the present research project.

Although competence-based PVSE has scarcely been investigated, policy documents of schools suggest that they are attempting to make their education more competence-based in several manners. Some schools report attempts to implement content characteristics of competence-based learning environments for practical subjects via, for example, the simulation of actual work situations. Other schools report the intention to implement forms of problem-based learning or project-based learning, in which certain practical and general subject areas are integrated, and in which student questions and student learning objectives form the starting point for learning. Still other schools report attempts to create multidisciplinary learning domains in which related school subjects — such as chemistry, biology and physics — are addressed in an integrated manner.

Internationally, research on learning environments has grown considerably and the characteristics of a wide range of learning environments have been investigated over the past few decades (Fraser, 1998). Nevertheless, the context for most of this research has been regular primary and secondary education. Much less attention has been paid to the vocational education context. Brief inspection of the content of eleven volumes of the journal *Learning Environments Research*, for instance, shows the word “vocational” to occur in only 21 out of more than 150 articles; only 7 of the articles are actually about vocational education or vocational learning); and only 1 of the articles is about *competence-based* PVSE learning environments. In the Netherlands, many schools are just beginning to implement the characteristics of competence-based education. Research on competence-based PVSE is thus in its infancy.

### 1.2.2 The learning processes of students in PVSE

As already mentioned, the goal orientations of students and information processing strategies which they use play an important role in their learning (Vermunt & Vermetten, 2004). Both the goal orientations and information processing strategies of students affect their learning outcomes or — within the context of the present research — the development of their knowledge. In the following, we will therefore consider the preferences of students for certain types of goal orientations, various information processing strategies and their knowledge development (see Figure 1.1 on page 19).

*Goal orientations*

Goal orientations of students reflect the types of goals which they prefer to pursue (van der Sanden, 2003). The goal orientation of a student can thus determine the amount of effort which he or she is willing to invest in a particular learning task (Driscoll, 1999). Several attempts have been made to categorize the different types of learning goals which students can have (e.g., Boekaerts & Simons, 2003; Bransford, Brown, & Cocking, 2000; Duda & Nicholls, 1992; Elliot & McGregor, 2001; Ng & Bereiter, 1991). *Mastery-oriented goals* and *performance-oriented goals* have been distinguished in some studies with *work-avoidance goals* also distinguished in other studies. Mastery-oriented goals are intrinsic goals which motivate students to learn and become competent. Performance-oriented goals are more extrinsic and related to social comparison and/or striving to achieve the best relative to others. Work-avoidance goals are more extrinsic and typically lead a student to do things reasonably well but with as little effort as possible. The preferences of students and other learners for particular goal orientations have been found to influence not only their motivation to learn but also the information processing strategies which they adopt and the extent to which they integrate the knowledge, skills and attitudes which they develop (van der Sanden, 2004). There is some empirical support for the claim that intrinsic mastery-oriented goals tend to foster the adoption of deeper information processing strategies and thereby lead to better learning results than more extrinsic goals. Students with a focus on extrinsic (i.e., performance and work-avoidance) goals tend to focus purely on the acquisition of knowledge which is known to elicit the use of more surface information processing strategies rather than deeper information processing strategies (Ausubel, 1968; Kaldeway, 2006; Novak, 2002; Rozendaal, 2002). Students in competence-based learning environments are therefore encouraged to develop a mastery-oriented goal orientation and adopt intrinsic learning goals (Boekaerts, de Koning, & Vedder, 2006).

*Information processing strategies*

The focus of research on student learning processes is frequently on the cognitive processes and information processing strategies used (Entwistle & McCune, 2004; Vermunt & Vermetten, 2004). Information processing strategies are the particular combinations of cognitive learning activities which directly refer to the processing of information for the attainment of particular learning goals (Vermunt, 1992). A distinction is often made between surface processing strategies (i.e., reproductive learning) and deep processing strategies (i.e., meaningful learning or learning aimed at improved understanding) (cf. Chin & Brown, 2000; Marton & Säljö, 1976; Novak, 2002; Rozendaal, 2002). Learners who adopt deep information processing strategies engage in such activities as: (a) the relating and structuring of learning content, (b) the critical processing of information and, (c) the concrete processing of information which can take the form of making mental depictions or linking information to other experiences including those outside school. In contrast, those learners who adopt surface processing strategies engage in mostly the memorizing and repeating of learning content and the analyzing of learning tasks (i.e., division of learning content into smaller bits and performance of tasks in a more or less prescribed order). The *preferences* of students and other learners for particular types of information processing have been found to affect their development of knowledge (Segers, Gijbels, & Thurlings, 2008). As might be expected, deep processing strategies are generally perceived to be superior to surface processing strategies (Struyven et al., 2006). In the present research, it is expected that a preference for deeper information processing strategies on the part of PVSE students will result in greater development of knowledge and a better quality of knowledge than a preference for more superficial information processing strategies (Vermunt & Vermetten, 2004).

*Development of knowledge*

In competence-based PVSE, the development and integration of knowledge is strived for. The learning of skills and attitudes occupies a more central position in competence-based education than in traditional education, but knowledge construction is still an important goal for students to become qualified and competent professionals (Bereiter, 1997; Everwijn, Bomers, & Knubben, 1993). Knowledge is obviously also required for PVSE students to function adequately in work situations (Eraut, 1994; Glaser & Bassok, 1989). Conceptual knowledge is necessary for PVSE students to reason and make decisions. Moreover, in competence-based education conceptual knowledge is not so much factual knowledge but knowledge which is of practical importance and which should generally be constructed by the students themselves (cf. Eraut, 1994).

PVSE students in competence-based education can thus be expected to develop practice-oriented knowledge for use in learning tasks which resemble tasks from actual professional practice (de Bruijn et al., 2005).

In line with contemporary theories of the development of knowledge (Novak, 2002), the knowledge of students in the present study is assumed to be stored in networks of concepts. When deep information processing strategies are deployed, new concepts and meanings are integrated into already existing cognitive structures (i.e., networks of concepts); these structures may then be modified or even restructured as a result of the integration of new information. Rather than solely drilling the content of learning or practicing with the content, knowledge development can be seen in terms of the active construction of conceptual structures by learners via the use of deep information processing strategies (Birenbaum, 2003). The knowledge constructed by students in such a manner is likely to be organized in theory-like structures which tend to be extensive and flexible but coherently organized around core concepts (Hmelo-Silver, 2004; Novak, 2002; Vosniadou, 2007a; Vosniadou, 2007b). The development of knowledge manifests itself in changes in the *elaborateness* and *organization* of a student's knowledge (Dochy, Segers, van de Bossche, & Gijbels, 2003; Glaser & Bassok, 1989; Scardamalia & Bereiter, 2006). More elaborate and better organized knowledge facilitates the retrieval of knowledge (Prawat, 1989; van Zele, Lenaerts, & Wieme, 2004). Enhanced knowledge retrieval will in turn affect the ability of students to apply their knowledge and skills in new learning contexts (Gijbels, Dochy, van de Bossche, & Segers, 2005; Hmelo-Silver, 2004).

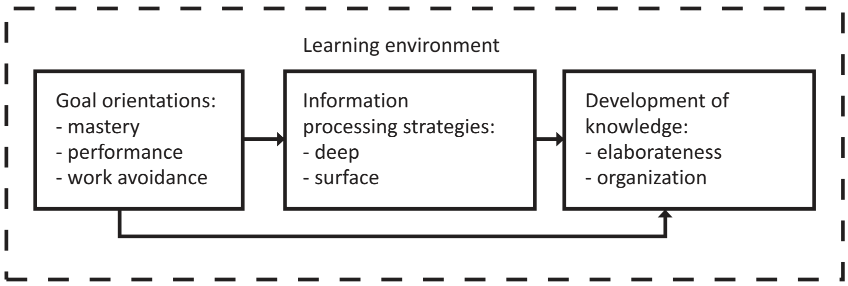


**Figure 1.1**: Conceptual model

*Conceptual model for the research*

In Figure 1.1, three aspects of student learning are distinguished: the goal orientations of students, the information processing strategies of students, and the knowledge development of students. This model constitutes the basis for this dissertation.

Little research has been conducted on the relation between learning environment characteristics and learning results in vocational education (de Kock, Sleegers, & Voeten, 2004, Oemar Said, 2009; Telli, den Brok, & Cakiroglu, 2008). In this study, the relation between characteristics of the learning environment and development of knowledge is investigated in different subject areas. Competence-based education is assumed to foster the development and integration of knowledge, skills and attitudes within these subject areas. The extent to which a learning environment is characterized as competence-based can be expected to positively influence the development of student knowledge.

## 1.3 Problem definition and research questions

Given the scarcity of research regarding learning processes of PVSE students, little information is also available on how the variables outlined in the conceptual model depicted in Figure 1.1 should be investigated within the context of PVSE in general and competence-based PVSE learning environments in particular. Greater insight into these variables and how they interrelate within the context of PVSE is thus needed to successfully adapt them to the principles of competence-based education and use with students in PVSE (van der Sanden, 2004).

Therefore, the purpose of the present study was to describe and explore the associations between student learning processes - in terms of goal orientations, information processing strategies and knowledge development – and the extent to which characteristics of competence-based education have been implemented into the PVSE setting. The general research question was: *What are the relations between the goal orientations, information processing strategies and knowledge development of students in competence-based PVSE?* This general problem was divided into the following, more specific central research questions:

(a) Which instruments appear to be most suitable to investigate the goal orientations, information processing strategies and development of knowledge of students in competence-based PVSE?
(b) What structural relations exist between the goal orientations, information processing strategies and development of knowledge of students in competence-based PVSE?
(c) What is the relation between the development of PVSE students' knowledge and the characteristics of competence-based learning environments?
(d) Which characteristics of the learning environment and which knowledge and behaviours of teachers regarding student guidance promote students' learning processes and development of knowledge?

Research question (a) will be addressed via the investigation and comparison of the psychometric properties of instruments used to investigate the goal orientations and information processing strategies of students; a procedure will be developed to investigate the development of knowledge by means of concept maps. The answer to this question will then be used to determine the suitability of different instruments to investigate student learning process variables in PVSE. Research question (b) will be addressed via the formulation of a model of the structural and hierarchical relations between preferred goal orientations, preferred information processing strategies and the knowledge development of students. The answer to this question should help us to better understand the cognitive learning processes of students in competence-based PVSE. Research question (c) will be addressed via the investigation of the relations between various characteristics of the learning environment, as perceived by teachers, and the development of student knowledge; correlations, t-tests and multilevel analyses of variance will be used for this purpose. The answer to this question should provide greater insight into the knowledge development of students in PVSE schools which differ on the extent to which and manner in which they have implemented characteristics of competence-based education. Research question (d) will be examined in a qualitative, in-depth analysis of the learning environment and type of guidance provided by teachers in a “good practice” case of competence-based PVSE. The findings with regard to this question should help other schools possibly confronting similar difficulties in the adaptation of their education to be more competence-based.

## 1.4 Theoretical and practical relevance

The present research aims to contribute to the building of theory with respect to student learning within a PVSE context by providing greater insight into the preferred goal orientations, preferred information processing strategies and learning results in terms of knowledge development of students. Insight will also be provided with respect to the relations between these three aspects of student learning. Given that information is gathered on the knowledge development of students in learning environments which are competence-based to a greater or lesser extent, the connections between various characteristics of the PVSE learning environments and student learning results can be assessed. The development of competence-based PVSE is still in its infancy, which means that very little research has been conducted on the learning of PVSE students within such environments. The present research will therefore contribute to the expanding theoretical basis for the understanding and design of competence-based education in general and competence-based PVSE in particular.

The present research also has methodological relevance. Little is known about how to measure the goal orientations, information processing strategies and knowledge development of students in PVSE. In the present research, the psychometric properties of a number of instruments within the context of PVSE are therefore tested and compared. This information will presumably be of use for researchers interested in the cognitive learning of students in PVSE and other contexts in which students have below average reading skills, a limited capacity for self-reflection and/or problems with abstract thinking. Besides, the study will contribute to manners in which knowledge development can be measured and analyzed. For this purpose, the use of the concept mapping technique is tested, which may constitute an innovative and potentially useful approach.

Finally, the results of the present research may also have practical relevance in that greater insight can be provided into student learning for not only researchers but also teachers. Based upon the outcomes of the research, suggestions can be made about how to align the preferences of students for certain learning goals and information processing strategies, on the one hand, and the characteristics of the learning environment, on the other hand. Also based upon the outcomes of the present research, recommendations can be made for the design of competence-based learning environments — recommendations with regard to both the content and organization of competence-based learning environments and how teachers can best guide students in such learning environments.

## 1.5 Context and participants

In the Netherlands, approximately 60% of the students between 12 and 16 years of age are in PVSE. PVSE starts with two years of more general education. In the third year, the students must choose a specific sector and a specific educational programme (i.e., a level within a sector). PVSE has the following four sectors: Care and Welfare, Technology, Business and Agriculture. Most PVSE students opt for the Care and Welfare sector (about 32% of all third and fourth year PVSE students in 2007). The Technology and Business sectors are chosen slightly less frequently (about 30% of all third and fourth year PVSE students choose Technology and about 30% choose Business). The Agriculture sector is the smallest PVSE sector in the Netherlands with only about 14% of all third and fourth year PVSE students opting for this sector in 2007. Each of the PVSE sectors can be divided into four programmes (see Table 1.1). These programmes differ in the degree of difficulty and in the ratio of theoretical to practical subjects. For example, in the basic vocational and middle management vocational programmes (i.e., most practice-oriented programmes) students follow mainly vocational subjects at a basic level of difficulty. In the combined and theoretical programmes (i.e., more theory-oriented programmes) students follow more general/theoretical subjects (such as mathematics, Dutch language or biology) at a higher level of difficulty. The purpose of PVSE is to prepare students for further Vocational Education and Training (VET)[1]. PVSE is thus not intended to be the student's final education and all of the subjects and topics addressed in the PVSE of students are intended to orient and prepare them for future education and work.

**Table 1.1:** Number of students in the third and fourth years of PVSE for 2007/2008 per programme[a]

| **Programme** | **Number of students** |
|---|---|
| Theoretical programme | 79240 |
| Combined programme | 23820 |
| Middle management vocational programme | 58920 |
| Basic vocational programme | 55460 |
| **Total** | **217440** |

(CBS StatLine)
[a] These numbers are presented to provide a global indication of the number of students in the third and fourth years of the different PVSE programmes; at least as many students are in the first and second years of PVSE.

Most of the students who participated in the present studies came from the Care and Welfare or Technology sectors of PVSE. Some of the students were in the first or second year and had therefore not chosen a sector. One school participated in the study particularly for an answer to research question (a), namely: Which instruments appear to be most suited for the investigation of student learning in competence-based PVSE? The student participants from this school were in their third year of the middle management vocational programme in the Care and Welfare sector; the school was middle-sized and part of a comprehensive school located in a city in the southern part of the Netherlands. A total of 14 schools participated in the studies undertaken to answer research questions (b) and (c), which concerned the interrelations between various aspects of student learning within the context of competence-based PVSE and the relations between the students' knowledge development and characteristics of competence-based PVSE. Of these 14 schools, 3 were public schools and 11 were denominational (i.e., publicly-funded catholic) schools. Only 1 of the 14 schools was a smaller school located in a village in the southern part of the Netherlands.

[1] In practice, a part of the students from the combined and theoretical programmes choose to continue education in senior general secondary education. Almost half of the PVSE students are in these two more general PVSE programmes. Although most PVSE students continue education in VET, a relatively large part of the students in the theoretical programme do not have to choose a specific PVSE sector with accompanying vocational subjects. Their programmes then only consist of more general subjects.

The other 13 schools were middle-sized or large branches of larger schools and located in cities in the southern part of the Netherlands. Data was collected while the students were working on a project which was a part of the larger curriculum. All of the investigated projects lasted anywhere from 20 to 30 hours across a period of eight to ten weeks. One of the 14 schools was found to be particularly successful with respect to the conduct of competence-based PVSE (see Chapter 6) and was therefore selected for more qualitative, in-depth study aimed at answering research question (d), namely: which characteristics of the learning environment and which knowledge and behaviours of teachers regarding student guidance promote students' learning processes and development of knowledge?

## 1.6 Overview of the study

In Chapter 2, different instruments for the measurement of the goal orientations of students in PVSE are compared. The psychometric properties of three instruments which can be used to identify the preferences of students for mastery, performance or work-avoidance orientations to learning are explored. This is done using a semi-structured interview, a questionnaire and a sorting task. The data gathered by means of these instruments are compared as a basis for determining the most suitable instrument.

In Chapter 3, a comparison of different instruments which can be used to identify the information processing strategies of PVSE students in a study comparable to the preceding study is described. The psychometric properties of three instruments used to identify the preferences of PVSE students for the use of deep or surface information processing strategies are explored in particular. This is done using a semi-structured interview, a questionnaire and the think-aloud method. The data gathered by means of these instruments are compared as a basis for determining the most suitable instrument. The results of the studies presented in Chapters 2 and 3 are used to select the instruments used in the studies reported in Chapters 4 and 5.

In Chapter 4, the development of student knowledge in PVSE schools which differ with regard to the extent to which and manner in which they have implemented various characteristics of competence-based education is described. The implementation of characteristics of competence-based education is assessed using a teacher questionnaire concerned with the content and organization of the learning environment and the type of student guidance provided by the teacher. The concept mapping technique is used to characterize students' knowledge development. This entails having students construct concept maps for a core concept addressed in an ongoing project on two separate occasions. A comparison of the pre- and post-test concept maps then provides insight into the students' knowledge development with regard to the core concept (central to the specific project investigated). Insights are presented about which learning

environments appear to elicit greater knowledge development and the relevant characteristics of these learning environments.

In Chapter 5, a study of the goal orientations, information processing strategies and knowledge development of PVSE students in 14 schools is described. The purpose of this study is to investigate the relations between these aspects of student learning within the context of PVSE. The students' knowledge development was charted via comparison of the concept maps created by them before and after participation in a learning project at the school. A structural model is then presented to characterize the nature of the relationships between the goal orientations, information processing strategies and knowledge development of PVSE students.

Chapter 6 deals with more qualitative insight into the manner in which the content and guidance dimensions of competence-based education are given form in a "good practice" school. More specifically, the knowledge and behaviour influencing student learning of two teachers who have implemented competence-based education with marked success are examined in-depth. Semi-structured interviews and observations were undertaken to gain insight into the teachers' conceptions of competence-based education and guidance of students, their actual behaviour and their explanations of their own behaviour. Student perceptions of the learning environment created by these teachers are also described.

Finally, in Chapter 7, the results of the studies described in the previous chapters are summarized for each of the research questions. This is followed by a general discussion of the findings, a number of practical implications, some limitations of the study and suggestions for future research.

In Table 1.2, a brief overview of the different chapters in this dissertation related to the four research questions is presented.

**Table 1.2:** Overview of the dissertation in relation to the central research questions

| Chapter | Title | Central research questions |
|---|---|---|
| 1 | Introduction | |
| 2 | How to investigate the goal orientations of students in competence-based pre-vocational secondary education: choosing the right instrument | (a) Which instruments appear to be most suitable to investigate the goal orientations, information processing strategies and development of knowledge of students in competence-based PVSE? |
| 3 | How to investigate the information processing strategies of students in competence-based pre-vocational secondary education: selection of the right instrument | (a) Which instruments appear to be most suitable to investigate the goal orientations, information processing strategies and development of knowledge of students in competence-based PVSE? |
| 4 | Development of student knowledge in competence-based pre-vocational secondary education | (a) Which instruments appear to be most suitable to investigate the goal orientations, information processing strategies and development of knowledge of students in competence-based PVSE?<br>(c) What is the relation between the development of PVSE students' knowledge and the characteristics of competence-based learning environments? |
| 5 | Learning processes of students in competence-based pre-vocational secondary education: relations between goal orientations, information processing strategies and development of knowledge | (b) What structural relations exist between the goal orientations, information processing strategies and development of knowledge of students in competence-based PVSE? |
| 6 | An in-depth study of competence-based learning environments in pre-vocational secondary education | (d) Which characteristics of the learning environment and which knowledge and behaviours of teachers regarding student guidance promote students' learning processes and development of knowledge? |
| 7 | Conclusions and discussion | |

# CHAPTER 2[2]

## How to investigate the goal orientations of students in competence-based pre-vocational secondary education: choosing the right instrument

**Abstract**

This study explores the psychometric properties of three instruments: a semi-structured interview, a questionnaire and a sorting task. The central question is which instrument is most suitable to investigate the goal orientations of students in competence-based Pre-Vocational Secondary Education. The questionnaire proved most accurate. The interview provided relevant supplementary information on the goals of the students and underlying motives. The sorting task appeared to be less suitable.

[2] This chapter has been published as: Koopman, M., Teune, P.J., & Beijaard, D. (2008). How to investigate the goal orientations of students in competence-based pre-vocational secondary education: choosing the right instrument. *Evaluation and Research in Education*, *21*(3), 318-334.

## 2.1 Introduction

In the Netherlands, around 60% of children between the ages of 12 and 16 years attend schools for pre-vocational secondary education schools (PVSE). These schools prepare students for post-secondary Vocational Education and Training (VET). The PVSE curricula differ in the degree of difficulty and in the ratio of theoretical to practical subjects. Furthermore, PVSE encompasses programs in four sectors: Care and Welfare, Technology, Business and Agriculture.

Recently, Dutch schools for PVSE have implemented different forms of competence-based learning environments, which are based upon social constructivist conceptions of learning. The focus in these environments is on the development of competences in which knowledge, skills and attitudes are integrated (van der Sanden, 2004). In contrast to the “traditional” focus on mainly knowledge acquisition, students are expected to learn in a largely self-directed, active and constructive manner (de Bruijn et al., 2005).

To successfully adapt the principles of competence-based education to student learning, greater insight into the goal orientations and motives of students is needed (van der Sanden, 2004). The goal orientations or motives of students can range from intrinsic to extrinsic (van der Sanden, 2003). Students in competence-based learning environments are encouraged to develop intrinsic learning goals (i.e., learning-oriented goal orientations). An orientation towards intrinsic learning goals can be realized by organizing the learning environment in such a manner that it appeals to students’ own interests and presents them with relevant and clearly recognizable tasks. Intrinsic learning goals cause students to make an effort to learn or become competent. It is generally known that these goals evoke deeper learning processes and thus deeper cognitive activities and better learning results than more extrinsic, pure knowledge-acquisition goals (Ausubel, 1968; Kaldeway, 2006; Novak, 2002; Rozendaal, 2002).

Little is known about the preferences of students in PVSE for certain goal orientations or how these can best be investigated. While a reasonable amount of research has been conducted on the goal orientations of students in higher education (see e.g. Vermetten, Lodewijks, & Vermunt, 2001), it is expected that the instruments used to do this cannot simply be adopted unaltered to investigate the goal orientations of PVSE students. In PVSE, for example, several specific characteristics of the students must be taken into account: (1) the reading skills of PVSE students are limited, and many find it difficult to read long sentences or unfamiliar words, (2) many PVSE students find it very difficult to formulate a representation for abstract concepts, (3) the capacity for self-reflection on the part of such students is often limited, which is known to complicate the conduct of research among this population, and (4) PVSE students may often have a rather short attention span (Driessen et al., 2005; Melis, 2003).

The aim of the present study was thus to generate information on the utility of available instruments to study PVSE students' preferences for goal orientations in particular. The psychometric properties of three instruments were investigated for this purpose: a semi-structured interview, a questionnaire and a sorting task. The main research question was: *Which of these instruments appears to be most suitable to investigate the goal orientations of students in competence-based PVSE?*

## 2.2 Goal orientations and how these can be investigated

### 2.2.1 The goal orientations of students

The goal orientations of students reflect the goals which they prefer to pursue (van der Sanden, 2003). Goals are the engine of learning (Dweck, 1986; Hubers, 2003; Nicholls, 1984; Onstenk, 2001). Goals determine the effort which a person is willing to put into a learning task (Driscoll, 1999). Assumptions regarding the importance of the goal orientations of students have received considerable empirical support (Dweck, 1986; Hubers, 2003; Nicholls, 1984). The preferred goal orientations of students have been found to influence not only the learning activities of the students but also the extent to which they integrate knowledge, skills and attitudes (van der Sanden, 2004). For example, a student who strives towards personal competence within a particular professional field will show a predisposition to learn about this field in a more self-directed manner and a greater predisposition to integrate new knowledge and skills with existing competences than a student who is primarily oriented towards achieving well. The former student will also probably pay greater attention to opportunities to apply what is being learned than the latter student as the former student views the content of what is being learned as relevant for his or her competence.

Several attempts have been made to classify the types of goals which students may pursue when learning (Boekaerts & Simons, 2003; Bransford, Brown, & Cocking, 2000; Duda & Nicholls, 1992; Elliot & McGregor, 2001; Ng & Bereiter, 1991). The various classifications show many similarities. In particular, preferences for learning-oriented goals (i.e., mastery) or achievement-oriented goals (i.e., performance) are distinguished with work-avoidance goals (i.e., doing things well but with as little effort as possible) sometimes added in as well.

This means that PVSE students can be hypothesized to have one of the following preferences: (a) a mastery orientation, (b) a performance orientation or (c) a work-avoidance orientation (cf. Duda & Nicholls, 1992). It is generally assumed, moreover, that a mastery orientation is superior to the other goal orientations for learning purposes (Boekaerts & Simons, 2003). More than performance or work-avoidance goals, mastery goals concern the content which the students are occupied with. In the case of competence-based PVSE, mastery goals are clearly linked to the competences for the vocation which the student wants to pursue in the future. Mastery-oriented learning within the domain of PVSE can thus be construed as the development of the knowledge, skills and attitudes required to pursue a particular vocation (van der Sanden, 2004).

### 2.2.2 The investigation of goal orientations and choices

There are several options to obtain information on the preferred goal orientations of students. One common option is the interview technique (Patton, 2002). Interviews can provide extensive information and profound insight into the preferences for goal orientations of students. Given the limited amount of knowledge available to date on the goal orientations of PVSE students, the most elaborate information possible on the goal orientations of such students was considered welcome.

To collect qualitative data on the goal orientations of the PVSE students, it was decided to conduct a semi-structured interview. Semi-structured interviews are labour-intensive but produce a rich body of data using relatively open and flexible methods (Mertens, 1998; Miles & Huberman, 1994). The interview topics and codes for the analysis of the data were based on a study of the literature regarding goal orientations.

The goal orientation preferences of students are also commonly investigated via the administration of questionnaires (Boekaerts, de Koning, & Vedder, 2006; Vermetten, Lodewijks, & Vermunt, 2001). The administration of questionnaires is an efficient means to collect data on a large number of participants. A questionnaire is typically deployed when sufficient knowledge exists with regard to the most relevant variables. For educational contexts other than the PVSE context, a fair number of questionnaires have been developed to investigate the goal orientations of students (e.g., Entwistle & McCune, 2004). The purpose of the present study, thus, was to discover if such a questionnaire is also suitable to investigate the goal orientations of PVSE students.

An example of a goal orientation questionnaire is the validated questionnaire from Duda and Nicholls (1992), which has been adapted to the Dutch context for use with PVSE students[3]. This questionnaire addresses the types of goal orientations outlined above. It has a relatively small number of items and it has also been made comprehensible for PVSE students. The questionnaire produces quantitative data and is less laborious than an interview.

A relatively more direct instrument to investigate the preferred goal orientations of students involves the administration of a sorting task during the actual conduct of a learning task. While the interview and questionnaire instruments investigate the goal orientations of students in a more or less indirect way, a sorting task administered in such a manner can directly link the learning orientations of students to their actual task performance. A sorting task was also therefore incorporated into the present study to investigate the goal orientations of PVSE students.

Via the administration of a sorting task during the performance of a learning task, data can be acquired on the learning goals which students have in mind when actually working on a task. The students are asked to pick a card with the type of goal which they are working on at several points during the performance of a task and to reflect upon the selected goal (cf. Ng & Bereiter, 1991). The reflection part of the instrument is quite open and thus provides qualitative data. The card-selection moments are considered closed and provide quantitative data. Nevertheless, when compared to the semi-structured interview and questionnaire instruments, the sorting-task instrument provides not only relatively rich information but also direct information on the goal orientations of the students during the conduct of an actual learning task. The administration of the sorting task and analysis of the qualitative part of the data is, however, time-consuming.

The three types of instruments selected for use in the present study were chosen because of their expected applicability to PVSE students. The characteristics of the three types of instruments are summarized in Table 2.1.

[3] **Acknowledgement**
The authors would like to thank Audrey Seezink for making available the version of the goal orientations questionnaire she adapted together with Johan van der Sanden for PVSE students.

**Table 2.1:** General characteristics of the three instruments

| | Semi-structured interview | Questionnaire | Sorting task |
|---|---|---|---|
| Type of data | Qualitative | Quantitative | Combination |
| Administration | Verbal | Written | Verbal |
| Structured/ unstructured | Semi-structured | Structured | Structured |
| Relation to learning situation | Indirect | Indirect | Direct |
| Labour intensity | High | Low | Average |
| Richness of data | High | Low | Average |

Given that the focus of the present study was on determination of which of the three types of instruments is most suitable to investigate the goal orientations of PVSE students, the data from these three instruments were compared.

## 2.3 Method

### 2.3.1 Participants

The PVSE students participating in this study were in their third year of a PVSE programme which prepared them for later middle-management and professional training (age 14 to 15 years). The students came from the Care and Welfare sector in a school which had implemented the following elements of competence-based education: integration of subject areas, tasks which resemble later professional practice, and authentic situations and competences as the starting point for the learning and practice of skills and knowledge. A total of 16 students completed the interview and the sorting task. The questionnaire was administered to the same 16 participants plus 34 of their peers (n=50).

### 2.3.2 Instruments

An overview of the specific instruments used in the present study is presented in Table 2.2. The interviews provided opportunities to pose extra questions, probe for details and ask for further explanation or clarification. The students were interviewed for 30 minutes; the interviews were audiorecorded and the tapes were later transcribed.

The questionnaire used in the present study consisted of 29 items rated along a five-point Likert scale (Duda & Nicholls, 1992). For each item, the students had to indicate the extent to which they felt satisfied with respect to a specific situation. The scores for three scales representing the different types of goal orientations could then be calculated.

The sorting task involved a representative learning task and five goal selection moments. While working on the task, the students were asked to select one of three cards as indicative of what they wanted to work on during the task and to reflect upon their choices by thinking aloud about why they chose the particular goal and the extent to which they had reached the goal (cf. Ng & Bereiter, 1991). The cards reflected the mastery, performance and work-avoidance orientations described above. The sessions were audiorecorded and later transcribed.

**Table 2.2:** Instruments and content of the instruments

| Instrument | Length | Scales/content | Sample of item/text on card |
|---|---|---|---|
| Semi-structured interview | Conversation of 30 minutes | Mastery | What kind of goals would you like to reach while working on this project? |
| | | Performance | |
| | | Work avoidance | |
| Questionnaire | 29 items; five-point Likert-scale | Mastery (10 items) | As a student, I feel satisfied when I learn something interesting. |
| | | Performance (10 items) | As a student, I feel satisfied when I do better than other students. |
| | | Work avoidance (9 items) | As a student, I feel satisfied when I don't have to do much work but get a good mark anyway. |
| Sorting task: choosing goals while working on a task | 5 selection moments; 3 choices per moment | Mastery | I want to understand how providing home help functions. |
| | | Performance | I don't want others to think I'm stupid in doing home help. |
| | | Work avoidance | I want to finish doing this home help task quickly. |

### 2.3.3 Design and procedure

Data collection occurred during a project of ten weeks for the PVSE students aimed at the development of knowledge, skills and attitudes concerning the domain of domestic care in the home and living facilities for people with a disability. All three instruments were administered to the same group of 16 students in order to determine if the same preference for a particular type of goal orientation was found for the same student using each instrument. In order to facilitate the comparison of the results from such very different instruments, the students were explicitly instructed to answer the interview and questionnaire items in relation to a particular context or learning situation; the administration of the interview and questionnaire instruments was also planned as close to the actual performance of project tasks as possible (van Hout-Wolters, 2006). To prevent the students from providing the same responses as a result of recognizing the similarities between the instruments, data collection was spread across the ten-week period (see Table 2.3). The distribution of data collection moments was not expected to influence the results as the goal orientations of the students can be expected to be persistent during such a short period of time. This project period was also representative of educational practice. In addition, the items from the different instruments were not literally the same. Most importantly, the instruments themselves were very different from each other.

**Table 2.3:** Time path and number of participants per instrument

| Instrument | Time path | Nª |
|---|---|---|
| Semi-structured interview | Beginning of the project | 15 |
| Questionnaire | Fourth week of the project | 49 |
| Sorting task | Seventh, eight and ninth weeks of the project | 14 |

ªNumber of students completing the test; less than 16 on the interview and sorting task and less than 50 on the questionnaire due to absence, illness or incomplete data provision.

### 2.3.4 Data analysis

The interview responses of the students were analysed using codes which were determined a priori. The statements were categorised using a coding scheme (Miles & Huberman, 1994) which was based upon information from the literature (Duda & Nicholls, 1992; van der Sanden, 2003). The statements of the students were linked to one of the three types of goal orientations. Sample codes were for example: “I want to become a competent …” (= mastery), “I want my parents to be proud of my marks” (= performance), and “I don’t want to put much effort into it” (= work avoidance). When a second rater coded 172 of the 915 statements produced by the students, an inter-rater reliability (Cohen's Kappa) of .92 was found. On the basis of the frequencies per coding category and goal orientation, the preferences of the students for a particular type of goal orientation could be identified (cf. Chi, 1997). When a preference for a specific type of orientation was not particularly clear, the following two decision rules were applied. For an almost equal distribution of responses across two types of goal orientations, both orientations were taken as the conclusion for the student. For a two thirds/one third distribution of responses across two types of orientations, the dominant orientation was taken as the conclusion for the student with the less dominant orientation indicated in parentheses to be also taken into consideration during the comparison with the conclusions from the other instruments (see Table 2.8).

The questionnaire data was examined by factor and reliability analyses. Given that the questionnaire was expected to distinguish the mastery, performance and work-avoidance orientations, scales reflecting these orientations were constructed after administration of the questionnaire using reliability analyses. No items were deleted. The reliability analyses produced Cronbach's alphas of .85 for mastery, .80 for performance and .72 for work avoidance (n=49). The average scores per student on the different scales were then calculated and, based on the highest average score per scale, a conclusion could be drawn about the student's preference.

For the sorting task, the choices made at the different goal selection moments were summed for the different types of cards in order to identify the students' preferred goal orientation during the actual performance of a learning task. A coding scheme based on the categorization of Duda and Nicholls (1992) was further used to categorize the reflective responses of the students. The inter-rater reliability for the coding of 63 of the 144 statements by two coders was .84 (Cohen's Kappa).

Per instrument, a conclusion could now be drawn with regard to the preferences of each student. That is, the preference of a particular student for one of the three types of goal orientations per instrument could be determined and subsequently compared to the preferences of the student on the other instruments. A conclusion regarding the *general goal orientation* preferred by the student could then be drawn. More importantly, the most suitable instrument to assess the goal orientations of students could be determined on the basis of these outcomes. In addition to the reliability of each instrument, attention was also paid to the validity of each instrument. First, the general goal orientation of each student was taken as a starting point and the correspondence of the student's outcomes per instrument was then examined with respect to this general orientation; when the conclusion for one of the instruments corresponded to the student's general goal orientation, the instrument was counted as suitable. The extent to which a particular instrument led to a conclusion other than the general goal orientation for a student was also determined.

## 2.4 Results

In this section, the results regarding the students' preferences for goal orientations per instrument will be described. Thereafter, the psychometric properties of the different instruments will be considered.

### 2.4.1 Goal orientations of students per instrument

*Semi-structured interview*
When the students were asked in general about the goal which they wanted to achieve, many of the students spontaneously mentioned getting a diploma as their main goal. When asked more specifically about their preferred goal orientation during the project being worked on, most of the students reported having a mastery orientation (e.g., n1, n3, n7, n8, n12; see Table 2.4). Sometimes this orientation was combined with a performance orientation. In other words, some of the students wanted to learn something due to personal interest but also wanted to meet the expectations of the people in their environment (n5). A performance orientation also seemed to be related to avoidance of family disappointment (n10, n13) but not peers or teachers. Only a few students indicated a predominant work-avoidance orientation. Yet, even these students showed a desire to develop competence and make an effort but only when the schoolwork was interesting or they thought they would need it (n7, n8). Matters of interest or importance to these students were things needed to perform their desired future profession. Unfortunately, almost all of the students appeared to have a narrow vision of what was relevant to learn for such a profession. They typically judged practical assignments or parts of these to be of importance. For other types of assignments and mostly more theoretical assignments, many of the students saw little or no connection to their future employment. As a result of this situation, more of the students indicated a mastery orientation within the context of the ongoing project than for school in general. With regard to the project as well, however, there were also students who were most interested in putting as little effort into their work as possible.

**Table 2.4:** Examples of interview statements typical of students per goal orientation

| Goal orientation | Statement |
|---|---|
| Mastery | - In principle, I would like to be able to really do it right. (n1).<br>- Trying to perform tasks right because then I've learned how it works. That's the reason why you are in school: to learn things. (n3)<br>- I would like to do it right. (Q: more important than marks?). For me, it involves marks but it involves learning more strongly…so that I know everything. (n7)<br>- Knowing everything about Care. (n8)<br>- Actually, at the end of a lesson, I want to have learned a lot. (n12) |
| Performance | - I want to get really good marks. I don't like getting bad marks. (n5)<br>- I want my parents to be proud of me as well. (n10)<br>- It's nice to perform well… They pay attention to you, like "How does she do it?". (n13) |
| Work avoidance | - I learn what is described in the assignment. For some assignments this goes well but for others I really don't like what I have to do. Then I don't feel like doing it and I want to finish it as quickly as possible. (n7)<br>- When it's boring, I want to work quickly and then it's finished. (n8) |

*Questionnaire*

After categorization of the results per student and consideration of the highest mean scale score per student, 35 of the 49 participants showed a preference for the mastery goal orientation; 1 student preferred a performance goal orientation; and 13 students preferred a work-avoidance goal orientation. The overall means and ranges for the questionnaire scale scores are presented in Table 2.5.

**Table 2.5:** Mean questionnaire scale scores

| | n | Minimum | Maximum | Mean | Std. deviation |
|---|---|---|---|---|---|
| Mastery | 49 | 1.00 | 5.00 | 3.93 | .73 |
| Performance | 49 | 1.00 | 4.70 | 3.20 | .74 |
| Work avoidance | 49 | 1.00 | 4.89 | 3.35 | .76 |

*Sorting task*

The sorting task provided information on the goal orientations of the students while actually working individually on a learning task which was very comparable to the types of assignments which they would usually perform. The results for this instrument are presented in Table 2.6.

**Table 2.6:** Types of goals chosen by students on five different moments during the sorting task[a][b]

| Student | Moment on which the goal was chosen 1 | 2 | 3 | 4 | 5 | Conclusion |
|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - |
| 2 | WA | M | P | M | - | M |
| 3 | M | M | M | M | M (P) | M |
| 4 | M | M | P | M | M | M |
| 5 | WA | M | M | WA | - | WA |
| 6 | M | WA | M | WA | WA | WA |
| 7 | WA | M | M | WA | P | M |
| 8 | M | M | M | M | M | M |
| 9 | WA | M | M | M | WA | M |
| 10 | WA | M | M | M | M | M |
| 11 | M | P | M | M | - | M |
| 12 | M | M | M | M | - | M |
| 13 | M | M | P | WA | - | M |
| 14 | WA | WA | WA | WA | P | WA |
| 15 | P | M | P | M | P | P |
| 16 | - | - | - | - | - | - |
| Total | M=7; P=1; WA=6 | M=11; P=1; WA=2 | M=9; P=4; WA=1 | M=9; P=0 WA=5 | M=4; P=3; WA=2 | M=10; P= 1; WA =3 |

[a]M= Mastery; P= Performance; WA = Work Avoidance
[b]In addition to the decision rules mentioned in Section 2.3.4, the following rule was used for the sorting task: When almost similar frequencies of goals chosen by the students were found, the students' reflections about these choices were used to determine the students' preferences

As can be seen, most of the students showed to prefer a mastery orientation (mastery=40; performance=9; work avoidance=16). Furthermore, when the participants were asked to clarify their choice of goal and evaluate whether they had reached the goal or not, the clarifications mostly concerned limitations on their prior knowledge. As one student put it in his explanation of wanting to work hard (i.e., a mastery orientation):

> *Because you don't know everything about lifting patients yet; you can always learn more.* (n2*)*

Sometimes the participants clarified the amount of effort being expended or their reasons for why they were satisfied with attaining a sufficient mark. Some of the students further mentioned liking to work at an easy pace while others mentioned being less quickly satisfied with their results. The following statements are representative of the work-avoidance orientation (n10) and the performance orientation (n15):

> *Being at ease; finishing everything in time. Taking care that I don't have to hurry to finish everything.* (n10)
>
> *It is about the marks too… I don't want to get a pass; I like to get a better assessment.* (n15)

### 2.4.2 Psychometric properties of the instruments

For the three instruments, only the interview results and the questionnaire results correlated significantly with each other (.69; p=.004; see Table 2.7). In other words, these two instruments seem to tap similar aspects of the goal orientations of the students studied here, which indicates the validity of the two instruments. Clearly significant correlations between the *general goal orientations* preferred by the students and both the interview and questionnaire were also found.

**Table 2.7:** Correlations between conclusions per instrument and general goal orientations of students

| | | Conclusion per instrument | | | General Goal orientation |
|---|---|---|---|---|---|
| | | Interview | Questionnaire | Sorting task | |
| Conclusion per instrument | Interview | 1.00 | | | |
| | Questionnaire | .69** | 1.00 | | |
| | Sorting task | .37 | .15 | 1.00 | |
| General goal orientation | | .99** | .88** | .31 | 1.00 |

** p < .01

Each of the instruments used to investigate the preferences for goal orientations of the students in this study can be seen to have its own advantages. In general, the questionnaire appeared to provide the most unambiguous information regarding the students' goal orientations. Given the nature of the interview, a more complete picture of the students was provided by this instrument, but it was less easy to categorize the students according to their goal orientations using the data from the interview than from the questionnaire. Using the average scale scores from the questionnaire, it was possible to draw more unequivocal conclusions regarding the goal orientations of the students. Significant correlations between the mastery and performance scales from the questionnaire (.457; p=.007) and the work-avoidance and performance scales (.394; p=.028) were found.

A similar dichotomy between learning-oriented goals (i.e., mastery combined with performance) and achievement-oriented goals (i.e., performance combined with work avoidance) was found in other research (Boekaerts & Simons, 2003). The data regarding the goal orientations of the students while actually working on a learning task had the benefit of allowing the identified goals to be directly related to the schoolwork being performed. However, the number of times which the students had to select a goal was restricted to five and so compared to the questionnaire consisting of 29 items and the probing opportunities of the interview, the amount of information gathered by means of the sorting task was rather limited.

The comparison of the *general goal orientations* preferred by the students (i.e., the most frequently occurring goal orientation when the orientations for the three instruments were compared) to the goal orientations of the students identified per instrument produced the pattern of results depicted in Table 2.8. When the goal orientation identified using a particular instrument matched the general goal orientation identified for the student, the instrument was judged to be suitable. As can be seen, the goal orientations for more than one of the instruments sometimes matched the general goal orientations identified for some of the students. In the end, however, the questionnaire was found to be the most suitable instrument (f=13).

**Table 2.8:** Comparison of the instruments used to investigate goal orientations

| Student | Conclusion per instrument[a] | | | General goal orientation | Most suitable instrument |
|---|---|---|---|---|---|
| | Interview | Questionnaire | Sorting task | | |
| 1 | M | WA | - | WA | - |
| 2 | P (WA) | WA | M | WA | Questionnaire |
| 3 | M | M | M | M | All three |
| 4 | P (M) | M | M | M | All three |
| 5 | M | M | WA | M | Interview/questionnaire |
| 6 | M | M | WA | M | Interview/questionnaire |
| 7 | M | M | M | M | All three |
| 8 | M | M | M | M | All three |
| 9 | WA / P | WA | M | WA | Questionnaire |
| 10 | M / P | M | M | M | Questionnaire/sorting task |
| 11 | WA | WA | M | WA | Interview/questionnaire |
| 12 | M (WA) | M | M | M | Questionnaire/sorting task |
| 13 | M / P | M | M | M | Questionnaire/sorting task |
| 14 | WA | WA | WA | WA | All three |
| 15 | P | M | P | P / M | Interview/sorting task |
| 16 | - | WA | - | WA | - |
| **Best instrument was that instrument for which the goal orientation results most often matched the general goal orientation identified per student** | | | | | **Questionnaire = 13x,** interview = 9x, sorting task = 8x |

[a] M= Mastery; P= Performance; WA= Work Avoidance

Finally, the extent to which an identified goal orientation diverged from the student's general goal orientation was analyzed according to the *type* of goal orientation. Considering the frequencies with which the goal orientation identified using a particular instrument was the same as the student's general goal orientation, the mastery and work-avoidance orientations were most frequently identified in keeping with the student's general goal orientation (see Table 2.9). The identification of a performance orientation was not only relatively infrequent but also more divergent. In general, the conclusions drawn per instrument frequently corresponded to the general goal orientations identified for the students. Divergent goal orientations, moreover, concerned mostly the interviews (f=6) or the sorting task (f=5) (see Table 2.8).

**Table 2.9**: Convergent and divergent goal orientations per instrument relative to general goal orientations of students

| General goal orientation | Instrument | Number of conclusions | Number of convergent conclusions | Number of divergent conclusions |
|---|---|---|---|---|
| Mastery | Interview | 9 | 25 | 4 |
| | Questionnaire | 10 | | |
| | Sorting task | 10 | | |
| Performance | Interview | 6 | 2 | 5 |
| | Questionnaire | 0 | | |
| | Sorting task | 1 | | |
| Work avoidance | Interview | 3 | 10 | 2 |
| | Questionnaire | 6 | | |
| | Sorting task | 3 | | |
| Total | | 48 | 37 | 11 |

## 2.5 Conclusions

The purpose of this study was to investigate the psychometric properties of three instruments which can be used to investigate the preferences for certain goal orientations by students in competence-based PVSE: interview, questionnaire and sorting task. The central question was which instrument is most suitable to investigate the goal orientations of such students. The results of the interview and questionnaire appeared to correspond best to the general goal orientations preferred by the students, that was based on the results of all three instruments. In addition, a significant correlation was found between the results of the interview and the questionnaire.

While the interview provided the most extensive and profound insights, the questionnaire produced the smallest number of divergent goal orientations when compared to the general goal orientations for the students. The sorting task was found to be least suitable. In contrast to the other instruments, the results of this instrument did not correlate with the results of the questionnaire and the interview. Apparently, the instruments do not all investigate the same aspects of the goal orientations. The interviews and questionnaires used in this study were indirect techniques although linked to the context of the project which the students were working on via the questions used and instructions provided. Despite these measures, we could not evade the problem regularly encountered in this type of research, namely a lack of correspondence between data gathered using direct versus indirect techniques (van Hout-Wolters, 2006).

In addition to the detected differences between the instruments, some practical considerations should be taken into account when choosing an instrument to investigate the preferred goal orientations of students. The practical considerations include the labour-intensiveness of interviews, for instance, versus the strong discriminative power of questionnaires. On the basis of the present results, we recommend the use of both interview and questionnaire techniques to investigate the goal orientations of PVSE students. Together, the interview and questionnaire techniques call upon both the verbal and reading capacities of the students who are known to have limited reading skills, abilities to make abstract representations and attention spans. While the questionnaire was found to be very accurate and adequate, the information collected by such an instrument tends to be quite limited. The interview, in contrast, constitutes a powerful instrument for the verification of conclusions and collection of supplementary information.

A few other notable results were found with respect to the questionnaire. Although clear and significant intercorrelations between the mastery and performance scales of the questionnaire and the performance and work-avoidance scales of the questionnaire were found, the discriminative power of the questionnaire was still better than that of the other instruments. The observed dichotomy in the goal orientations of the students has been found in other studies (Boekaerts & Simons, 2003) and seems to reflect the fact that students who want to develop their competences are also interested in performing well. On the other hand, students with a predominantly work-avoidance orientation may nevertheless be sensitive to group pressure or group norms and sense that wanting to work hard is something to not be open about. Almost no performance orientations were identified on the part of the students using the questionnaire. In the interviews, however, this occurred a few times. It is possible that the PVSE students have relatively little interest in fulfilling the expectations of parents or teachers. The mastery and work-avoidance orientations manifested themselves more often. Therefore, in PVSE in addition to the scales from many other instruments available to investigate the goal orientations of learners, we recommend the use of questionnaires which not only have mastery and performance scales, but also a work-avoidance scale, as such an orientation is quite regularly preferred by students in this level of secondary education.

An important finding revealed by the interviews was the insight that the preferred learning goals of PVSE students are strongly related to the perceived importance of the particular learning task. When a task is perceived as necessary to perform well in a future job, students are found to typically want to learn and perform well. However, most of the PVSE students studied here were found to have a rather limited view of what is relevant for their future profession. The sorting task showed students reporting a mastery orientation to be relatively more critical of themselves and less quickly satisfied than other students when asked to judge the extent to which their learning goals were achieved during the learning task.

The present study was carried out with a relatively small number of participants, conducted within a single school and involved only one PVSE sector. This obviously has consequences for the generalizability of the present results. Despite this limitation, however, considerable information was acquired on the suitability of different instruments to investigate the goal orientations preferred by this particular type of student. Three very different instruments were intentionally selected for consideration in this study: two instruments involving largely indirect data collection and one instrument involving more direct data collection. Use of a sorting task allowed us to investigate the goal orientations of the PVSE students at a micro-level (i.e., specific moments during the performance of a particular assignment). It is possible that the goal orientations of students are more stable and thus related to clusters of assignments and the result of a longer school period, which makes the investigation of the goal orientations of students on a more general level using indirect instruments such as interviews and questionnaires most suitable.

# CHAPTER 3[4]

## How to investigate the information processing strategies of students in competence-based pre-vocational secondary education: selection of the right instrument

**Abstract**

In the Netherlands, many Pre-Vocational Secondary Education schools are implementing elements of competence-based education. These learning environments are expected to elicit the use of deep information processing strategies and to positively influence learning outcomes. While questionnaires are often used to investigate the preferences of students for particular types of information processing strategies in other educational contexts, these instruments cannot simply be adopted unaltered for use in Pre-Vocational Secondary Education where several characteristics of the students must be taken into account. This study explores the psychometric properties of three instruments for the measurement of student preferences for deep or surface information processing strategies in competence-based Pre-Vocational Secondary Education. The utility of a semi-structured interview, a questionnaire, and the think-aloud method was investigated. The questionnaire appeared to be the most accurate instrument and allowed easy classification of students in terms of their information processing preferences. The think-aloud method provided profound insight into the information processing strategies that the students preferred for a learning task and the frequencies with which the strategies were used. The interview results largely corresponded to the results produced by the other measurement instruments, but the interview data lacked the expected richness and depth.

[4] This chapter has been submitted for publication as: Koopman, M., Teune, P., & Beijaard, D. *How to investigate the information processing strategies of students in competence-based pre-vocational secondary education: selection of the right instrument*.

## 3.1 Introduction

In the Netherlands, the majority of students between the ages of 12 and 16 years are in Pre-Vocational Secondary Education (PVSE). This type of education prepares students for further Vocational Education and Training (VET). PVSE encompasses four sectors: Care and Welfare, Technology, Business, and Agriculture.

Currently, many PVSE schools are implementing elements of competence-based education. The development of competences and the necessary integration of knowledge, skills, and attitudes are striven for in competence-based learning environments (van der Sanden, 2004). Competence-based learning environments developed for this purpose are expected to elicit the use of deep information processing strategies and to positively influence learning outcomes as a result (Gijbels, Coertjens, Vanthournout, Struyf, & van Petegem, 2008).

Obviously, to successfully implement characteristics of competence-based education for student learning, insight into the learning processes of PVSE students is necessary (Struyven, Dochy, Janssens, & Gielen, 2006). Therefore, the focus of the present study is on those cognitive learning processes that are essential for the development of knowledge (Vermunt, 1992). Although skills and attitudes are given a more central position in competence-based education than in traditional forms of education, the construction of knowledge still remains an important objective for the preparation of students to later become qualified professionals. Knowledge is an essential component of competence and certainly necessary to make adequate decisions (Eraut, 2004; van der Sanden, 2004). Sufficient deep information processing is essential for the construction of knowledge (Novak, 2002). That is, a distinction is often made between the use of deep or surface information processing strategies for learning purposes with the use of deep information processing strategies producing better learning results (Struyven, Dochy, Janssens, & Gielen, 2006).

In higher education, a reasonable amount of research has been conducted on the relations between characteristics of the learning environment and the information processing strategies used by learners. Certain characteristics of the learning environment appear to elicit deeper information processing (Gijbels et al., 2008), such as learning in authentic contexts and cooperative learning. While questionnaires are often used to investigate the preferences of students for particular types of information processing strategies in higher education, these instruments cannot simply be adopted unaltered for use in PVSE where several characteristics of the students must be taken into account. To start with, the reading skills of PVSE students are limited; many PVSE students find it difficult to read long sentences or unfamiliar words. Second, many PVSE students find it very difficult to formulate a representation for abstract concepts. The capacity for self-reflection on the part of such students is often limited, and this is known to complicate the conduct of research among this population. Finally, PVSE students often have short attention spans (Driessen et al., 2005; Melis, 2003).

The aim of the present study is thus to generate information about the utility of various instruments from different educational contexts to investigate the preferences of PVSE students for deep or surface information processing strategies. The psychometric properties of three instruments will be investigated for this purpose: a semi-structured interview, a questionnaire, and the think-aloud method. These instruments were selected for study because their utility and quality have been demonstrated in other contexts including higher education for the questionnaire, for example, and we want to investigate the utility of using more direct versus indirect methods to gain insight into student information processing preferences. The main research question was therefore: *Which of these instruments appears to be most suitable to investigate the information processing strategy preferences of students in competence-based PVSE?* The present study can thus contribute to our knowledge of the utility of particular research instruments for use within PVSE in general and competence-based PVSE in particular.

### 3.1.1 Types of information processing strategies

Research on learning processes is often focused on the cognitive processing of information or so-called information processing (Entwistle & McCune, 2004; Vermunt & Vermetten, 2004). The approaches to learning and the information processing strategies of students are frequently described in terms of reproductive or rote learning versus meaningful learning or learning for understanding. Different information processing strategies involve different combinations of learning activities that directly entail the processing of data for the attainment of specific learning goals (Vermunt, 1992).

Two types of information processing strategies can generally be distinguished: *deep processing strategies* or *surface processing strategies* (cf. Chin & Brown, 2000; Marton & Säljö, 1976; Novak, 2002; Rozendaal, 2002). Students employing deep information processing strategies engage in such learning activities as: (a) the relating and structuring of learning content, (b) the critical processing of information, and (c) the concrete processing of input (e.g., making mental depictions of the information provided) (Vermunt, 1992). Conversely, students employing surface processing strategies engage in such learning activities as: (a) memorizing and repeating the learning content, and/or (b) analyzing (i.e., the division of learning content into smaller chunks, the performance of tasks in a prescribed order) (Vermunt, 1992).

It is generally assumed that, considering learning results, deep information processing is superior to surface information processing (Struyven et al., 2006). Students who employ deep information processing strategies tend to be interested in and focus on understanding the learning content, relating parts of the learning content to each other, and the linking of new information to prior knowledge or experiences (Chin & Brown, 2000). Such learners have been found to be more effective with regard to their learning results than surface learners who tend to simply memorize separate facts and reproduce concepts and procedures via rote learning. In contrast to deep learners, surface learners often isolate learning content from other tasks and experiences outside the school. The depth of information processing is supposed to be determined by the personal goals of the student during the performance of a learning task (Biggs, 1994; Chin & Brown, 2000; Dweck, Mangels, & Good, 2004; Prawat, 1989; Rozendaal, 2002). In the present study, it is therefore hypothesized that the use of deep information processing strategies by PVSE students will result in a greater development of knowledge than the use of surface strategies by PVSE students.

Within the context of competence-based education, it is expected that the use of deep information processing strategies should be encouraged (Struyven et al., 2006). This can be done via the promotion of characteristics that are known to elicit or “force” deeper learning. Among such characteristics are the authenticity of the subject to be studied, the integration of subject areas, the use of tasks that resemble professional practice, and the adoption of authentic situations and competences as the starting point for the learning and practice of knowledge and skills (de Bruijn et al., 2005; Schelfhout, Dochy, Janssens, Struyven, & Gielen, 2006; Sluijsmans, Straetmans, & van Merriënboer, 2008; Wesselink, Biemans, & Mulder, 2007). For competence-based education, the learning content may thus be delivered using a mixture of teaching methods and sources of information with a clear emphasis on the interaction between and with students and the receipt of input from students (de Bruijn et al., 2005). Such instruction should prompt students to undertake deeper information processing and thus induce more meaningful learning. That is, the student may try to relate the learning content to his or her personal interests and goals. The student may work to integrate new information with the knowledge that he or she already possesses (Ausubel, 1968; Novak, 2002; Trigwell & Prosser, 1991). And knowledge will be actively constructed by the student (Birenbaum, 2003). That is, the knowledge of a student develops when new concepts are integrated into existing cognitive structures and, as a consequence, the existing structures are modified or even completely restructured (Hmelo-Silver, 2004; Novak, 2002; Vosniadou, 2007a, 2007b).

Little is known about the information processing of PVSE students and the preferences that they have with regard to that. Prior research has shown PVSE students to prefer learning activities that involve the processing of concrete information; such students often find it difficult to select information for processing, interpret information, and regulate their own learning (van der Neut, Teurlings, & Kools, 2005). Rozendaal (2002) has nevertheless shown PVSE students to employ both deep and surface information processing strategies and the employment of such a combination of strategies to be most effective with respect to learning outcomes. More specifically, some of the PVSE students showed a preference for one or the other type of strategy while others used deep and surface strategies about equally often. The preference scores for deep information processing were slightly higher than those for surface information processing.

### 3.1.2 Investigation of the information processing strategies of PVSE students

There are several options available to investigate the information processing preferences of PVSE students. One option is the interview technique (Patton, 2002). Interviews can provide extensive information and profound insights into the preferences of students. To attain such qualitative data on the information processing preferences of students within the context of the present study, it was therefore decided to conduct — among other things — semi-structured interviews. A semi-structured interview is labour-intensive but usually produces a rich body of data (Mertens, 1998; Miles & Huberman, 1994). This is certainly desirable in light of the limited amount of knowledge available on the preferences of PVSE students for different types of information processing strategies.

The information processing preferences of students are also commonly investigated via the administration of questionnaires (Entwistle & McCune, 2004; Vermunt & Vermetten, 2004). The administration of a questionnaire to a large number of participants is an efficient method of data collection. A questionnaire is generally deployed when sufficient knowledge exists with regard to the most relevant variables. In educational contexts other than PVSE contexts, a number of questionnaires have been developed to investigate the information processing strategies of students and their preferences with regard to such (e.g., Entwistle & McCune, 2004). Given that the purpose of the present study was to determine if the use of a questionnaire is also appropriate to investigate the information processing preferences of PVSE students, an already existing questionnaire was adapted for this purpose. More specifically, a questionnaire developed by Vermunt, Bouhuijs, Piccarelli, Kicken, and Andree (2006) has already been validated for the study of the information processing strategies of students in general secondary education. It was thus decided to use this questionnaire in the present study, not only because it addresses the types of information processing distinguished above, but also because it has a relatively few number of items and has already been made comprehensible for students comparable to PVSE students. The questionnaire produces quantitative data and is less laborious than an interview.

A relatively direct measurement instrument to investigate the information processing predispositions or preferences of PVSE students is to have students think aloud during the actual conduct of a learning task or the so-called think-aloud method. While the interview and questionnaire instruments investigate the preferences of students in an indirect manner, the think-aloud method directly assesses the preferences of students for particular types of processing during actual task performance. The think-aloud method produces a rich array of data on the processing strategies of students by asking them to continually state what they are thinking (i.e., think out loud) (cf. Ericsson & Simon, 1998). The technique is quite open and thus provides qualitative data, but its use and the analysis of the data are very time-consuming.

The three types of measurement instruments selected for use in the present study were thus selected in light of their expected utility for the investigation of students' preferences for the information processing strategies. The characteristics of the three types of instruments are summarized in Table 3.1.

**Table 3.1:** General characteristics of the three measurement instruments

| | Semi-structured interview | Questionnaire | Think-aloud session |
|---|---|---|---|
| Type of data | Qualitative | Quantitative | Qualitative |
| Administration | Verbal | Written | Verbal |
| Structured/ unstructured | Semi-structured | Structured | Unstructured |
| Relation to learning situation | Indirect | Indirect | Direct |
| Labour intensity | High | Low | High |
| Richness of data | High | Low | High |

Given that the focus of the present study was on the identification of which of the measurement instrument was best suited to investigate the preferences for information processing strategies of PVSE students, the data collected by the three different instruments were compared.

## 3.2 Method

### 3.2.1 Participants

The PVSE students who participated in this study were in their third year of a PVSE program that prepared them for a subsequent VET study and later middle management functions. The students were 14 to 15 years of age and all came from a school in the Care and Welfare sector that had implemented the following elements of competence-based learning environments: integration of subject areas, tasks that resemble later professional practice, and the adoption of authentic competences and situations as the starting point for the learning and practice of knowledge and skills. A total of 16 students completed both the interview and the think-aloud task. The questionnaire was administered to the same 16 participants plus 37 of their peers (n=53).

### 3.2.2 Measurement instruments

An overview of the measurement instruments used in the present study can be found in Table 3.2. The interview topics were based upon a review of the literature with regard to information processing. The semi-structured nature of the interviews provided opportunities to pose extra questions, probe for details, and request further explanation or ask for clarification. The students were each interviewed for about 30 minutes; the interviews were audiorecorded and transcribed.

The questionnaire consisted of 25 statements to be rated along a five-point Likert scale (Vermunt et al., 2006; 1= definitely not true, 5= definitely true). For each statement, the student had to indicate the extent to which they preferred to carry out certain processing strategies with respect to a specific situation. The questionnaire encompassed two scales: deep processing strategies and surface processing strategies. Deep processing strategies entailed such learning activities as relating and structuring, critical processing, and concrete processing. Surface strategies entailed such learning activities as memorizing and repeating, and analyzing. Scores for the two scales representing the different types of information processing strategies could thus be calculated.

The task used for the think-aloud session involved a representative learning task that took about 45 minutes to complete. While working on the task, the students were asked to state everything that they thought (i.e., think out loud) (cf. Ericsson & Simon, 1998). The sessions were audiorecorded and transcribed. The students' verbalizations were then linked to either deep or surface processing strategies.

**Table 3.2:** Content of the instruments

| Instrument | Scales/content | Sample of item/verbalization student |
|---|---|---|
| Semi-structured interview | Deep strategies | Which activities have you carried out while working on this project? |
| | Surface strategies | |
| Questionnaire | Deep strategies (10 items) | I try to link what I learn in school to things I know from the world outside school |
| | Surface strategies (15 items) | I learn series of important concepts by heart |
| Think-aloud session | Deep strategies | I'm going to summarize everything now |
| | Surface strategies | I'm going to copy this from the text |

### 3.2.3 Design and procedure

Data collection occurred while a project of 10 weeks was conducted with the PVSE students. The aim of the project was to develop knowledge, skills, and attitudes regarding domestic care in the home and the living facilities for people with a disability. All three instruments were administered to the same group of 16 students in order to determine if the same preferences for a particular type of information processing strategy were revealed for the same student using the different instruments. To facilitate the comparison of results, students were explicitly instructed to answer the interview and questionnaire items with respect to the ongoing project; the interview and administration of the questionnaire were also planned as close to the conduct of specific project tasks as possible (van Hout-Wolters, 2006). To prevent the students from providing similar responses as a result of recognition of similarities between the instruments, the collection of the data was nevertheless distributed across the 10-week project period (see Table 3.3). The exact point of data collection was not expected to influence the results as the preferences of students for particular processing strategies can be expected to be fairly stable across such a brief period of time. This project period was also representative of educational practice. Moreover, the items on the different instruments were not literally the same and, perhaps most importantly, the instruments themselves were very different from each other.

**Table 3.3:** Measurement occasion and number of participants per instrument

| Instrument | Measurement occasion | nª |
|---|---|---|
| Semi-structured interview | Beginning of the project | 15 |
| Questionnaire | Tenth week of the project | 49 |
| Think-aloud session | Either seventh, eighth, or ninth week of the project | 14 |

ªNumber of students involved; less than 16 for the interview and think-aloud session and less than 53 for the questionnaire due to absence, illness, or incomplete data provision.

### 3.2.4 Data analysis

The interview responses of the students were coded using a scheme derived from the literature (Entwistle & McCune, 2004; Vermunt, 1992; Vermunt et al., 2006). Deep information processing strategies were specified in learning activities such as "relating and structuring," "critical processing," and "concrete processing" with sample verbalizations accompanying each category of activity. Surface information processing strategies were specified in learning activities such as "memorizing and repeating" and "analyzing" with sample verbalizations accompanying each category of activity. Examples of such verbalizations are: "I look for relations between learning content and prior experiences" (= deep processing code) and "I try to learn facts by heart" (= surface processing code). When a second rater coded 172 of the 915 verbalizations produced by the students in the interviews, an inter-rater reliability coefficient (Cohen's Kappa) of .92 was found. On the basis of the frequencies for the two overarching coding categories, the preferences of the students for deep or surface information processing strategies could be determined (cf. Chi, 1997). When a clear preference was not apparent, the following two decision rules were applied. For an almost equal distribution of the coding frequencies for the two types of information processing strategies, both strategies were taken to hold for that student. For a two-thirds/one-third distribution of the coding frequencies for the two types of strategies, the strategy with two-thirds was taken to hold for that student (i.e., representing the dominant information processing strategy); the less dominant strategy was indicated in parentheses and thus available for consideration during the comparison of the results for the different instruments.

The questionnaire data were examined with the aid of factor analyses and reliability analyses. Given that the questionnaire was expected to distinguish preferences for deep and surface processing strategies, scales reflecting these strategies were constructed. No items were deleted. A Cronbach's alpha of .79 was found for deep processing and one of .83 for surface processing (n=49). The average scale scores were then calculated per student and, on the basis of the highest mean scale score, a conclusion could be drawn about the student's information processing preferences.

For the think-aloud sessions, the information processing strategies mentioned by the students were summed per type to identify the processing strategy preferred by the student during the actual performance of a learning task. A coding scheme similar to that used for the interviews and thus based on Vermunt (1992) was used to code the verbalizations of the students during the think-aloud sessions. The inter-rater reliability for the coding of 127 out of 825 verbalizations by two coders was .84 (Cohen's Kappa).

Per instrument, a conclusion could thus be drawn with regard to the information processing preferences of each student. A conclusion regarding the *general preference* of a student for a particular information processing strategy or combination of strategies could also then be drawn on the basis of the information from each instrument. More importantly, the most suitable instrument to assess the information processing strategies of students could be determined on the basis of these outcomes. In addition to the reliability of the instruments, the validity of the instruments was also considered. The general preference identified for each student was taken as the starting point and the correspondence of the student's outcome per instrument was then compared to this general preference. When the conclusion for a specific instrument corresponded to the student's general preference, the instrument was counted as suitable. When the conclusion for a specific instrument did not correspond to the student's general preference, the instrument was counted as unsuitable.

## 3.3 Results

In the following, the preferences of the students for deep or surface information processing strategies will first be described per instrument. The psychometric properties of the different instruments will then be presented.

### 3.3.1 Information processing strategies revealed by the semi-structured interview

The majority of the students in the interviews reported the use of surface information processing strategies. About one-third of the students mentioned use of both surface and deep information processing strategies. With regard to the use of surface strategies, most of the students mentioned the performance of tasks in the manner and order prescribed by their books and manuals. The cramming of learning content was also mentioned by most of the students. Table 3.3 contains examples of the surface strategies referred to in the interviews (n3; n5)

Only a small number of the students in the interviews indicated the use of mainly deep processing strategies while learning (see Table 3.4). Deep processing appeared to be primarily carried out in addition to surface processing. Students mainly mentioned concrete processing (n6) when they reported any use of deep information processing strategies. Critical processing (n11) was only mentioned by a few students in the interviews. A larger number of students mentioned the association of learning content with prior knowledge or experiences from outside the school (relating and structuring; n12).

**Table 3.4:** Examples of interview verbalizations typical of students per information processing strategy

| Information processing strategy | Verbalization |
|---|---|
| Deep strategies | - Most of the time I write down things that I think are really important. […] I write them down because I think they're important. The meaning of those words too, and then I know what it's about. I learn that extra well. (relating & structuring; n12)<br>- I often think a lot about "do I agree with this?", "would I do it this way?", "Is it efficient to do it this way?", "Can't it be done better?" (critical processing; n11)<br>- I'm a person who thinks "all right!" when reading something: I see images of how it works in my head. (concrete processing; n6) |
| Surface strategies | - Learning those strings by heart, so to say. But my goal is to really know it, to remember it. (memorizing and repeating;n3)<br>- I think I do everything step by step. For example, when I don't understand step 1, I do it again or I ask a question about it. Because, if you don't understand step 1, you will maybe not be able to understand step 2 of the task you're doing either (analyzing; n5) |

### 3.3.2 Information processing strategies revealed by the questionnaire

After categorization of the questionnaire responses per student and examination of the highest mean scale score per student, 7 of the 49 students showed an apparent preference for deep processing; 40 showed a preference for surface processing; and 2 showed equal scale scores for deep and surface processing. The overall means and ranges for the questionnaire scale scores are presented in Table 3.5.

**Table 3.5:** Mean questionnaire scale scores

| | n | Minimum | Maximum | Mean | Std. deviation |
|---|---|---|---|---|---|
| Deep strategies | 49 | 1.40 | 4.50 | 2.69 | .61 |
| Surface strategies | 49 | 1.86 | 3.36 | 3.32 | .55 |

### 3.3.3 Information processing strategies revealed by the think-aloud sessions

The think-aloud sessions provided information on the information processing strategies preferred by the students while working individually on a learning task that was very comparable to the types of assignments usually completed. An overview of the results for the think-aloud instrument is presented in Table 3.6.

**Table 3.6:** Frequencies of processing strategies reported by students during completion of tasks in think-aloud sessions

| Student | Information processing strategies | | Conclusion |
|---|---|---|---|
| | Deep strategies[a] | Surface strategies[b] | |
| 1 | - | - | - |
| 2 | 49 (27) | 40 (38) | Deep (surface) |
| 3 | 35 (16) | 20 (19) | Deep (surface) |
| 4 | 36 (24) | 18 (16) | Deep |
| 5 | 24 (11) | 44 (36) | Surface |
| 6 | 29 (15) | 24 (23) | Deep/surface |
| 7 | 28 (9) | 29 (21) | Surface/deep |
| 8 | 14 (9) | 22 (19) | Surface |
| 9 | 26 (15) | 21 (21) | Deep/surface |
| 10 | 30 (14) | 22 (20) | Deep (surface) |
| 11 | 39 (20) | 37 (23) | Deep/surface |
| 12 | 44 (17) | 36 (29) | Deep/surface |
| 13 | 40 (23) | 18 (17) | Deep |
| 14 | 29 (14) | 18 (17) | Deep (surface) |
| 15 | 35 (24) | 24 (24) | Deep (surface) |
| 16 | - | - | - |

[a]concrete processing in parentheses
[b] analyzing in parentheses

As can be seen, rather indistinct preferences for the use of deep or surface processing strategies could be found. Most of the students performed the task in exactly the order prescribed in the manual. "Analyzing" was therefore the surface learning strategy used the most as indicated in parentheses in Table 3.6. This is illustrated below with what one student mentioned while working on the task.

> *Let's take a quick look at the text to see which chapters there are… [Student reads text]. Now I've read the text, so now I can start to read the tasks. (n2)*

Memorizing and repeating were not mentioned quite as often, probably because the students were not specifically asked to do so as part of this particular learning task. The following verbalization is nevertheless an instance of a student performing a learning activity related to memorizing and repeating.

> *They ask what prosthesis is and now I'm going to see if I can copy it from the text. [Spelling] P-r-o-s-t-h-e-s-i-s… (n5)*

Deep processing strategies were reported almost equally often as surface processing strategies in the think-aloud sessions. Of the three deep processing strategies, "concrete processing" was most frequently reported as indicated in parentheses in Table 3.6. Students regularly reported making a mental depiction of what they had to do or thinking up examples from the world outside school. The following verbalizations are examples of students who processed information in a concrete manner.

> *I simply know…I heard it on TV once. (n7)*
>
> *Now I'm in my head…I'm thinking about how I would do it myself at home to make it easier. (n13)*

With respect to the deep learning activity of "relating and structuring", the students mostly related the learning task to what they have done previously in other subject areas at school. They also sometimes summarized the central issues in a text. With respect to "critical processing", three students reported using such deep processing activities to a relatively greater extent than other students. These students tried to follow the train of thought in the assignment and/or compared their own opinions to the information provided. The following verbalizations are representative of relating and structuring (n7) and critical processing (n11).

> *We had to do this last time and then we had everything wrong. So now I know how to do it right. (n7)*
>
> *[Student quotes from text] "Step 11: When the patient […]." That's impossible; the patient can't even stand on her own feet: She's paralyzed! (n11)*

### 3.3.4 Psychometric properties of the instruments

The interview, questionnaire and think-aloud results correlated significantly with each other (see Table 3.7). While the sizes of the correlation coefficients were probably limited by the small numbers of cases, the three instruments nevertheless appear to tap into similar aspects of the students' information processing preferences, which suggests that the instruments are all valid.

**Table 3.7:** Correlations between conclusions per instrument and general information processing strategies of students

| | | Conclusion per instrument | | | General information processing strategies |
|---|---|---|---|---|---|
| | | Inter-view | Question-naire | Think aloud session | |
| Conclusion per instrument | Interview | 1.00 | | | |
| | Questionnaire | .52* | 1.00 | | |
| | Think-aloud session | .64** | .53* | 1.00 | |
| General information processing strategies[a] | | .84** | .69** | .86** | 1.00 |

[a] The most frequently reported strategy when the preferences for the three instruments were compared.
* p< .05
** p< .01

Each of the instruments used to investigate the preferences for information processing strategies of students in the present study can be seen to have its own advantages. The questionnaire seemed to provide the most unambiguous information regarding the preferences of the students. When the average scale scores from the questionnaire were used, it was possible to draw more univocal conclusions with regard to the preferred information processing strategies than when the interview or think-aloud results were used. The finding of a significant correlation between the reported use of deep and surface processing strategies for the questionnaire ($r=.53$; $p=.00$) shows students who prefer more surface strategies to *also* prefer more deep processing strategies. Given the nature of the interview a more complete picture of the students was expected to be attained with this instrument. In this study, however, this was not the case. And the analyses of the data from the think-aloud sessions had the advantage of allowing the identified strategies to be directly related to the schoolwork being performed.

Clearly significant correlations were found between the *general preferences* of the individual students for particular information processing strategies or a combination of strategies and the preferences indicated by the interview, questionnaire, and think-aloud results (see Table 3.7). The comparison of the *general preferences* of the students to the preferences identified *per instrument* produced the pattern of results depicted in Table 3.8. When the preference for an information processing strategy identified by a particular instrument matched the general information processing strategy identified for a particular student, the instrument was judged to be suitable. As can be seen, the preferences identified per instrument often matched the generally preferred information processing strategies identified for the students. In the end, however, the interview proved to be the most suitable instruments with 12 matches, as opposed to 11 matches for the questionnaire and 10 matches for the think-aloud instrument.

**Table 3.8:** Comparison of the instruments used to investigate information processing strategies (less dominant strategy in parentheses)

| Student | Conclusion per instrument[a] | | | General information processing strategy | Most suitable instrument |
|---|---|---|---|---|---|
| | Interview | Questionnaire | Think-aloud method | | |
| 1 | S | - | - | - | - |
| 2 | S | S | D(S) | S | Interview/questionnaire |
| 3 | S(D) | S | D(S) | S | All three |
| 4 | D | D | D | D | All three |
| 5 | S | S | S | S | All three |
| 6 | S(D) | D | D/S | D/S | Interview/think-aloud |
| 7 | S(D) | S | S/D | S/D | All three |
| 8 | S/D | S | S | S | All three |
| 9 | S | S | D/S | S | All three |
| 10 | S | S | D(S) | S | Interview/questionnaire |
| 11 | S/D | D | S/D | S/D | Interview/think-aloud |
| 12 | S | S | D/S | S | All three |
| 13 | D | S | D | D | Interview/think-aloud |
| 14 | S | S | D(S) | S | Interview/questionnaire |
| 15 | S | S | D(S) | S | Interview/questionnaire |
| 16 | - | S | | - | - |
| Most suitable instrument was that instrument which most often matched the general information processing strategy identified per student | | | | | Interview = 12x<br>Questionnaire = 11x<br>Think-aloud = 10x |

[a] D = deep strategies; S = surface strategies

Finally, the overall degree of convergence between a preference identified *using a particular instrument* and the *generally preferred information processing strategies* identified for the students was determined. Per type of processing strategy (i.e., deep or surface), the frequency with which the preferred information processing strategy identified by the different instruments agreed or disagreed with the general preference identified for the individual students was calculated. When the conclusion found using a particular instrument corresponded to the general preference identified for the individual student, the particular conclusion was considered *convergent*. When the conclusion found using a particular instrument differed from the general preference identified for the individual student, the particular conclusion was considered *divergent*. As can be seen from Table 3.9, a preference for surface processing was most frequently identified in keeping with the student's generally preferred information processing strategy and thus convergent. A preference for deep processing was, in contrast, less frequently identified in keeping with the student's generally preferred information processing strategy and thus more divergent. Nevertheless, the conclusions drawn per instrument frequently corresponded to the general information processing preferences identified for the students. The divergent preferences, moreover, stemmed mostly from the interviews (in 2 cases) or the think-aloud sessions (in 7 cases) (see Table 3.8).

**Table 3.9:** Number of cases of convergence and divergence for the preferred information processing strategies identified per instrument relative to the generally preferred information processing strategies identified

| General information processing strategy | Instrument | Number of conclusions | Number of convergent conclusions | Number of divergent conclusions |
|---|---|---|---|---|
| Deep strategies | Interview | 7 | 13 | 9 |
| | Questionnaire | 3 | | |
| | Think-aloud sessions | 12 | | |
| Surface strategies | Interview | 12 | 34 | 1 |
| | Questionnaire | 11 | | |
| | Think-aloud sessions | 12 | | |
| Total | | 57 | 47 | 10 |

## 3.4 Conclusions and discussion

The purpose of this study was to generate information on the utility of three measurement instruments for the study of the preferences for information processing strategies of students in competence-based PVSE. The psychometric properties of the following instruments were investigated: a semi-structured interview, a questionnaire, and a think-aloud method. The main research question was which of these instruments appeared to be most suitable to investigate the preferences for information processing strategies of PVSE students. All three instruments corresponded almost equally well to the general information processing preferences identified for the students or, in other words, to the results attained using all three instruments.

The think-aloud sessions provided profound insights into the information processing strategies used by the students during the actual performance of a learning task. The method thus supplied information that was rich and direct. The interview also provided information that was richer than that provided by the questionnaire. Nevertheless, the questionnaire produced a very small number of divergent preferences when the preferred information processing strategies identified by a particular instrument were compared to the general information processing preferences of the students as well. Significant correlations were found between the results for the three instruments, which suggests that the three instruments measure largely the same aspects of the information processing preferences of students. It is nevertheless very difficult to compare data gathered via direct versus indirect means (van Hout-Wolters, 2006; Veenman, 2006). In the present research, we managed to avoid this problem by having the students answer all questions with regard to their learning behaviour within the context of the project being conducted. To further facilitate the comparison of the data collected using direct versus indirect techniques, the qualitative data were coded using the same categories as the quantitative data (i.e., the deep or surface scales from the questionnaire).

Considerable information was acquired on the suitability of the different measurement instruments studied here for the investigation of the information processing preferences of PVSE students. Our suggestion is that both the questionnaire and the think-aloud instruments should be used. The think-aloud method provides a rich source of information regarding the processing preferences of students, including their motives for the use of particular strategies in specific situations. The think-aloud method also appeared to be suited to assess the *frequency* of specific strategy use. Although the information gathered using the questionnaire is more limited in nature, the information can nevertheless be used to easily and accurately categorize students in terms of their preferred information processing strategies and verify information gathered using the think-aloud method. Using the think-aloud and questionnaire methods together, the strengths of not only direct but also indirect methods of data collection are drawn upon. It is also suggested that the two methods be used together in order to cater to the possible differences between PVSE students as well. It is conceivable, for example, that some students are more comfortable with the questionnaire method and others with the think-aloud method.

In addition to the psychometric properties of the instruments summarized above, some practical considerations should be taken into account for the selection of the most suitable measurement instrument. The think-aloud method is, for instance, a rather time-consuming method when compared to the administration of a questionnaire to gain insight into the preferred information processing strategies of students. The categorization of students is easier using a questionnaire. And although the psychometric properties of the interview method were also found to be satisfactory, the other two instruments are preferred within the context of PVSE for the following reasons in addition to the above. The interviews were expected to provide a rich source of information, but the information they provided was found to be rather superficial in the end. In actual PVSE practice, that is, the students seem to find it difficult to reflect upon their information processing. These students thus appeared to benefit from the strong guidance provided by a questionnaire or the directness of the think-aloud session caused by the availability of a concrete learning task.

The present study was carried out with a relatively small number of participants, conducted in a single school, and involved only one PVSE sector. Therefore, the present findings cannot be generalized as yet. Nevertheless, some tentative conclusions can be drawn about the learning of students in PVSE. The data from the interviews and the questionnaire showed the students in PVSE to apply mostly surface information processing strategies. The think-aloud sessions also provided insight into the use of deep information processing strategies by the PVSE students. When processing information at a somewhat deeper level, PVSE students show a clear preference for the concrete processing of information as opposed to the relating and structuring of information or the critical processing of information, which nevertheless reflect deep information processing as well. These students, in other words, were able to make mental representations of bits of information and link this information to prior experiences. Such behaviour has also been reported in other studies of PVSE (van der Neut, Teurlings, & Kools, 2005).

The questionnaire showed a significant correlation between the two scales that it was supposed to distinguish. Students with high surface processing scale scores often had high deep processing scale scores as well. This correlation suggests that students preferring one type of information processing strategy to a considerable extent also prefer the other type of information processing strategy to a high extent as well and vice versa. Stated differently, these students appear to prefer to carry out more learning activities that reflect both types of information processing strategies. In contrast, other students appear to undertake very few learning activities as a whole and irrespective of whether the activities involve the surface or deep processing of information. Rather than measuring a *preference* on the part of the students in a PVSE context, that is, the questionnaire may possibly measure the frequency of use for the two types of information processing strategies in general. In this respect, the present results regarding the information processing strategies of students in PVSE appear to differ from the results regarding information processing strategies of students in higher education, where sometimes no such correlation between the deep and surface information processing scales is found (Gijbels, 2005).

# CHAPTER 4[5]

# Development of student knowledge in competence-based pre-vocational secondary education

**Abstract**

The purpose of this study was to gain insight into the development of student knowledge in pre-vocational secondary education schools which differ in the manner and extent to which they have implemented characteristics of competence-based education. The implementation of these characteristics was examined using a teacher questionnaire. The development of knowledge was investigated using the method of concept mapping. The results showed students to develop slightly more knowledge in learning environments with fewer characteristics of competence-based education. The organizational characteristics of the learning environments were further found to be distinctive for the development of knowledge.

[5] This chapter has been accepted for publication as: Koopman, M., Teune, P., & Beijaard, D. Development of student knowledge in competence-based pre-vocational secondary education. *Learning Environments Research.*

## 4.1 Introduction

This research focuses on the development of student knowledge within the context of recently developed (competence-based) learning environments in Dutch pre-vocational secondary education (PVSE). There were several reasons for conducting this study. First, during the last decades, learning environment research has grown considerably (Fraser, 1998). The context in which learning occurs and through which learning outcomes are affected has been mainly investigated in regular secondary education and in primary education. Much less attention has been paid to the context of vocational education. For example, scanning the content of eleven volumes of the *Learning Environments Research* journal showed that out of the more than 150 articles, 21 articles contained the word "vocational", whereas only seven of these articles actually dealt with studies in the context of vocational education and/or with vocational learning. Since large numbers of students attend schooling in vocational education, the role of the learning environment in this context deserves more attention. Second, research into learning environments has often focused on the relation between motivational aspects of learning or student achievement and students' perceptions of the learning environment (Fraser, 1998; Telli, den Brok, & Cakiroglu, 2008; Wubbels, Brekelmans, den Brok, & van Tartwijk, 2006). The *development* of knowledge, especially outside traditional subject areas such as science or mathematics, has been scarcely investigated.

Our choice to focus on the particular context of the Netherlands had specific reasons as well. In the Netherlands, around 60% of children between 12 and 16 years of age attend pre-vocational secondary education schools. PVSE curricula in the Netherlands differ in the degree of difficulty (four levels running from basic to theoretical are distinguished) and in the ratio of theoretical to practical subjects. Furthermore, PVSE in the Netherlands encompasses programs in four sectors: Care and Welfare, Technology, Business and Agriculture. Currently, students in Dutch schools for PVSE are increasingly being confronted with different forms of *competence-based learning environments* largely based upon social constructivist conceptions of learning. The focus of learning in such environments is on the development of competences which are supposed to integrate knowledge, skills and attitudes (Eraut, 2004; Guile & Young, 2003). Some schools have advanced strongly in their development of competence-based education while others have only implemented a few elements as yet. This opens opportunities for studying the effects of non-traditional learning environments (Fraser, 1998).

Competence-based PVSE schools generally strive to create powerful learning environments that aim for students to work on complex and challenging learning tasks and to develop problem-solving and collaborative learning skills (de Corte, 2003; Merrill, 2002; Könings, Brand-Grüwel, & van Merriënboer, 2005). In such environments, the manner in which the process of active construction and integration of knowledge, skills and attitudes is guided appears to be important (Kirschner, Sweller, & Clark, 2006; van Merriënboer & Paas, 2003). In research on learning environments, characteristics of these environments often are classified into dimensions. These dimensions typically constitute a dimension concerning the *content and organization* of the environment and a dimension concerning the *interaction between persons* (e.g., Moos, 1979; Watzlawick, Beavin, & Jackson, 1967). In this study, characteristics of powerful learning environments were operationalized in similar dimensions, using the classification of de Bruijn et al. (2005), consisting of a content dimension and a guidance dimension. The content dimension concerns the manner in which learning content is dealt with in the learning environment. The guidance dimension concerns the different types of student guidance provided by teachers, such as coaching or the provision of feedback. The advantage of the dimensions discerned by de Bruijn et al. (2005) is that these were originally developed for competence-based learning environments in vocational education.

Competence-based education is assumed to foster the development and integration of knowledge, skills and attitudes. Learning skills and attitudes occupy a more central position in competence-based education than in traditional education. However, the construction of knowledge still remains an important objective for students to become qualified professionals. That is, knowledge is an essential component of competence and necessary to make adequate decisions under different circumstances (Eraut, 2004; van der Sanden, 2004). As can be concluded from the first paragraph, little is known, however, about the effects of learning environments on the actual knowledge development of PVSE students in general and those in non-traditional (here: competence-based) learning environments in particular. The central question in the present research was therefore: *What is the relation between the development of PVSE students' knowledge and the characteristics of competence-based learning environments?* The answer to this question may contribute to better understanding of the development of student knowledge in PVSE schools which differ in the extent to which and manner in which they implement the characteristics of competence-based education. The extent to which the learning environment can be considered competence-based is expected to have a positive influence on the development of student knowledge. For example, the implementation of characteristics of competence-based education has been found to positively affect students' self-regulated learning (de Bruijn et al., 2005), development of skills and remembering acquired knowledge (Dochy, Segers, van den Bossche, & Gijbels, 2003), and deeper learning (Blumberg, 2000). In this study, the elaborateness and organization of the students' knowledge were of particular interest as these aspects of students' knowledge have been found to be indicative of the quality and development of their knowledge (Scardamalia & Bereiter, 2006).

## 4.2 Knowledge development in competence-based education

### 4.2.1 Knowledge development

In competence-based education meaningful learning is aimed for. For such learning to occur, students must relate learning content to their own personal interests and goals. That is, meaningful learning (Ausubel, 1968; Trigwell & Prosser, 1991) involves the conscious integration of new knowledge into the knowledge which the learner already possesses (Novak, 2002). Such integration surpasses rote learning which merely involves the more or less arbitrary incorporation of unchanged new information into existing cognitive structures (Novak, 2002). In contrast to rote learning, meaningful learning can promote the further development of knowledge (Novak, 2002; Pintrich, Marx, & Boyle, 1993). The construction of knowledge involves concepts to be related to each other and new concepts to be integrated into existing knowledge structures in a conscious and logical manner.

Research on learning environments and school effectiveness research is generally oriented towards investigating the *quantity* of students' knowledge. In this study, however, attention is paid to the development of the *quality and structure* of students' knowledge. Regarding the quality and structure of knowledge, the elaborateness of student knowledge and the way in which this knowledge is organized are important (Liu, 2004; Sweller & Sweller 2006; Vosniadou, 2007b). The development of knowledge is essential for a student to become a competent beginning professional, and it is expected that meaningful learning and the development of knowledge are effectively promoted by competence-based education (Biemans, Nieuwenhuis, Poell, Mulder, & Wesselink, 2004; Gulikers, Bastiaens, & Martens, 2005). Learning environments with competence-based characteristics are intended to be powerful and thereby elicit knowledge construction. This may be done, for example, via the integration of related subject areas, the adoption of authentic situations as the starting point for knowledge construction and the creation of room for student input. In schools which have adopted such characteristics, students are also likely to organize that which is learned in a different manner. For example, that which is learned in competence-based learning environments may be linked to real life working situations and go beyond direct school subject matter more directly than in traditional learning environments, because the learning content is more relevant for the students to start with (van der Sanden, 2004).

### 4.2.2 Competence-based learning environments

Characteristics of competence-based learning environments are of critical importance for the promotion of meaningful learning and the development of knowledge. In learning environments research, dimensions that influence learning are often distinguished (Moos, 1979; Watzlawick et al., 1967), and because of the innovative character of competence-based education, it is important that proper attention is paid to the influence of these dimensions and accompanying characteristics. In prior research by de Bruijn and Overmaat (2002) and de Bruijn et al. (2005), a content and a guidance dimension of competence-based learning environments were used to describe the degree to which learning environments in Dutch vocational education could be considered powerful. The content and the guidance dimensions each consist of several components.

De Bruijn et al. divide the content dimension into four components along which schools can differ: the actual subject matter (e.g., authenticity of the subject to be studied, integration of subject areas, tasks which resemble professional practice, learning-to-learn); the structure and range of the subject matter (e.g., the adoption of competences and authentic situations as the starting point for the learning and practice of knowledge and skills); the delivery of the subject matter (e.g., use of a mixture of teaching methods, different sources of information, input from students, interaction with students); and forms of processing for the subject matter (e.g., active learning, exploratory learning, reflective learning) (cf. de Bruijn & Overmaat, 2002; see also Schelfhout, Dochy, Janssens, Struyven, & Gielen, 2006; Sluijsmans, Straetmans, & van Merriënboer, 2008; Wesselink, Biemans, & Mulder, 2007). The guidance dimension concerns the characteristics of the systematic guidance provided by teachers, experts and peers, but also the guidance, clarification and promotion of the student learning trajectory via a fixed programme order; the provision of guidance aimed at the learning of skills; and the guidance of learning processes using different forms of guidance (e.g., instruction, demonstration, thinking aloud, allowing autonomous student work, active support, coaching, provision of help when necessary, evaluation, feedback) (cf. de Bruijn & Overmaat, 2002; see also Entwistle & Peterson, 2004; van Grinsven & Tillema, 2006; Schelfhout et al., 2006).

De Bruijn et al. (2002; 2005) translated these dimensions into a questionnaire with scales consisting of items belonging to the content and guidance dimensions. Three content scales were distinguished, namely *type*, *power,* and *customary* (cf. de Bruijn & Overmaat, 2002). The *type* scale reflects the degree to which the organization of the learning environment can be typified as potentially powerful in terms of the four components of the content dimension of competence-based education. The *power* scale reflects the degree to which those components considered powerful in advance were actually realized in the particular learning environment. The *customary* scale reflects the extent to which less powerful characteristics are present in the organization of the relevant learning environment, and can as such be considered a control variable. For the guidance dimension, three scales were distinguished, namely *strong guidance*, *total guidance* and *growth* (cf. de Bruijn & Overmaat, 2002). *Strong guidance* reflects the provision of systematic guidance, structured learning routes and the tools which students need to perform the necessary tasks. *Total guidance* reflects the nine different forms of guidance which could be provided during the student's education. *Growth* reflects the provision of relatively more guidance in the later years of a student's education than in the initial years, and is calculated as a difference score (degree to which the nine forms of guidance were used in students' later years minus degree to which the nine forms of guidance were used in students' first years). Analysis of the data by de Bruijn et al. resulted in a classification of the participating Vocational Education and Training schools (VET; PVSE prepares students for VET) across the dimensions, with three types discerned: schools scoring above average on both dimensions, schools scoring below average on both dimensions, and mixed schools scoring high on one but low on the other dimension. Results of the study by de Bruijn et al. showed that only a few learning environments of the participating schools could be described as strongly competence-based (de Bruijn & Overmaat, 2002). Ambiguous relations between learning environments characteristics, motivation and course results were found (de Bruijn et al., 2005). For example, some learning environment characteristics had a negative influence on student motivation whereas others had the expected positive influence. However, the dimensions did have a positive influence on student progress (de Bruijn et al., 2005).

Reliability analysis resulted in Crohnbach's alphas between .55 and .85 (except from the *strong guidance* scale, every scale had sufficient reliability). Analysis for construct validity showed that the content dimension scales of *type* and *power* correlated positively and that negative significant correlations were found between both the *type* and *power* scales and the control variable *customary*. The guidance dimension scales of *strong guidance* and *growth* were also positively related.

In this study, the instrument of de Bruijn was used to describe and classify the learning environment. In accordance with other research into learning environments, perceptions of the learning environment were used to investigate its characteristics (de Bruijn et al., 2002; 2005). In this research, teachers' perceptions of the learning environment they created were used because relatively new learning environments were investigated. Therefore, it was expected that students would not be very capable to judge a situation they were not accustomed to yet.

### 4.2.3 Measuring development of students' knowledge

In order to measure the development of students' knowledge in terms of elaborateness and organization, a suitable research method had to be selected for the present study. Knowledge is often measured using tests (Linn, Baker, & Dunbar, 1991). An alternative method is concept mapping which is typically used to effectuate knowledge elicitation in groups (e.g., as a tool for brainstorming by professionals or other experts), as a learning strategy (e.g., as an aid for studying or writing structured texts) or as an instrument for assessment and diagnosis (Akinsanya & Williams, 2004; Budd, 2004; Buzan, 1991; Trochim, 1989). Concept mapping can also be used to visualize the organization of people's knowledge and the elaborateness of this knowledge (cf. Akinsanya & Williams, 2004; Boekaerts & Simons, 2003; Novak, 2002). Similarly, the development of learners' knowledge can be investigated and evaluated across a given time span using concept maps. Concept maps consist of knowledge in terms of concepts and the relations or links between those concepts (Novak, 2002). When analyzing concept maps, attention can thus be paid to the number of nodes and links, the relevance and relative importance of the concepts in the maps, the types of connections between the concepts, the depth (i.e., number of layers) in the maps and the general content of the maps (i.e., clusters of concepts) (Liu, 2004; Mavers, Somekh, & Resorick, 2002; Ruiz-Primo, Schultz, Li, & Shavelson, 2001). These features provide information on the quality of knowledge regarding a particular topic and appear to be well-suited for the measurement of PVSE students' knowledge over time. The elaborateness and organization of student knowledge can be investigated by means of concept mapping, allowing for measurement separate from context or school type, which would not be possible using traditional tests.

In learning environments and school effectiveness research, the development of students' knowledge has been found to be influenced by not only the learning environment but also by gender, age and prior knowledge. Girls often demonstrate greater knowledge development than boys (van Langen, Bosker, & Dekkers, 2006). Studies in the field of developmental psychology also show age to affect the learning process and the degree of knowledge elaboration and organization (Gathercole, 1998). Those students with greater prior knowledge have been found to also perform better when such learning outcomes as the elaboration and organization of knowledge are measured (Boekaerts & Simons, 2003). This may cause differences between students within PVSE. Although little research has been conducted on the development of knowledge of PVSE students, their prior knowledge may certainly differ across PVSE sectors and programmes.

Based on the theoretical framework, we can now formulate more specific research questions:

- How do the learning environments as perceived by teachers and classified in three types (above average, below average and mixed) relate to the development of student knowledge in PVSE?
- How do the content and guidance dimension of competence-based education as perceived by teachers relate to the development of student knowledge?
- How do the background variables age, gender, sector and programme relate to the development of student knowledge?

## 4.3 Method

### 4.3.1 Participants and context of the study

Dutch PVSE consists of four programmes in four sectors. As described earlier, the four programmes differ in the degree of difficulty and in the ratio of theoretical to practical subjects. For example, in the basic vocational programme (the most practice-oriented programme) students mainly follow vocational subjects on a basic level of difficulty. In the combined and theoretical programmes (the more theory-oriented programmes) students are mainly engaged in general subjects on a higher level of difficulty. The middle management vocational programme is in between the basic and the combined programme.

A convenience sample across different PVSE programmes in the southern part of the Netherlands was taken with the criterion for the selection of the schools being the presence of elements of competence-based education. The students involved in the study came from either the Care and Welfare or Technology sectors and from different *learning environments* (n= 14; see Table 4.1). All learning environments in this study involved a new project or topic studied over a period of several weeks. One shared aspect of all learning environments was that attention was paid to the development of knowledge. Knowledge and the concepts relevant to general education subjects (e.g., mathematics, geography) played an important part in all of the environments. Another shared aspect of all environments was that a core concept could be distinguished and thus supply the basis for the construction of a concept map by the students. All of the environments lasted for about 25 hours of scheduled education across a period of eight to ten weeks.

Students (N= 812) participating in the present study were in the first, second or third year of PVSE. The PVSE students came from different programmes which varied from mainly practice-oriented to mainly theory-oriented programmes. Two groups of students (64 of the 812 students) were also included from the first or second year of Vocational Education and Training (VET; secondary vocational education) in order to examine the possible differences between PVSE and VET students (i.e., different level students). Some of the first- and second-year students had not chosen a sector as yet as this simply was not possible in their school; this is indicated with an X in Table 4.1. Teachers involved in the investigated learning environments participated voluntarily in the study. All teachers had more than three years of teaching experience and were involved in the development of tasks in the learning environments. There was no non-response among teachers, though non-response occurred with students due to absence, illness or incomplete data supply. In subsequent multilevel analysis, missing values were replaced with estimates using the missing values analysis command in SPSS (cf. Trautwein & Lüdtke, 2009).

**Table 4.1:** Participants

| Learning environment | Year | Sector | Programme | n students |
|---|---|---|---|---|
| A | 1+2 | Technology | Both practice and theory-oriented | 49 |
| B | 1 | Technology | Mainly practice-oriented | 41 |
| C | 2 | Technology | Mainly theory-oriented | 17 |
| D | 2 | Care & Welfare | Mainly practice-oriented | 114 |
| E | 2 | Care & Welfare | Mainly practice-oriented | 14 |
| F | 1+2 | x | Both practice and theory-oriented | 103 |
| G | 2 | x | Both practice and theory-oriented | 205 |
| H | 3 | Technology | Mainly practice-oriented | 14 |
| I | 3 | Care & Welfare | Mainly practice-oriented | 34 |
| J | 3 | Care & Welfare; x; x | Mainly practice-oriented; mainly theory-oriented; mainly theory-oriented | 66 |
| K | 3 | x | Mainly theory-oriented | 62 |
| L | 3 | x | Mainly theory-oriented | 29 |
| M | 1 | VET[a] Technology | Level 4 | 22 |
| N | 2 | VET Technology | Level 2 | 42 |

[a] Vet = Vocational Education and Training; PVSE prepares students for VET training.

### 4.3.2 Data collection

Two types of data were collected: information regarding the learning environments and information regarding the development of knowledge. The development of student knowledge was investigated using concept mapping. A pretest and a posttest were administered in order to compare the quality of students' concept maps and knowledge across a period of eight to ten weeks in which they were involved in a particular project. Prior to pretesting, a questionnaire was administered to the teachers to obtain information on the extent to which and manner in which characteristics of competence-based education were implemented by them.

*Learning environments questionnaire*
Learning environments could differ in the degree to which they involved elements of competence-based education and a questionnaire was therefore administered in which a teacher, also involved in the development of the learning environment, was asked to describe the manner in which the education was organized (de Bruijn et al., 2005). The procedure developed by De Bruijn et al. (2005) was followed for the scales, dimensions and the identification of types of learning environments. The questionnaire contained items about the two dimensions consisting of characteristics of competence-based education.

More specifically, the questionnaire consisted of four groups of three questions each regarding one of the four components of the *content* dimension of competence-based education and one group of three questions regarding the *guidance* dimension. For the content components, each time a series of three related elements of competence-based versus three related elements of more traditional forms of education were mentioned and the respondents had to indicate: (a) which of the two series of descriptions was preferred, (b) which of the two series of descriptions best fitted the current learning environment, and (c) the extent to which the mentioned elements were present in the current learning environment (see Figure 4.1 for an example). Respondents had four answering options for each of the content items with respect to the preferred or actual situation: (1) closer to the first than to the second series of statements, (2) closer to the second than to the first series of statements, (3) completely according to the first series of statements, (4) completely according to the second series of statements. A three-point scale was constructed for the subquestions asking for the degree to which each of the statements in the series were true for the current situation (question c): “not at all”, “to some degree” or “to a large degree”. Based on all these questions, three content scales were constructed, namely, *type*, *power,* and *customary* (see Section 4.2.2). The scales provide information about the degree to which the content components are implemented in the learning environments.

The group of three guidance elements concerned the systematic guidance provided while the students learned independently. Respondents had to indicate for one item containing two series of three statements: (a) which of the two descriptions was preferred, (b) which of the two descriptions best fitted the current learning environment, and (c) the extent to which the elements mentioned in the statements were present in the current learning environment. Answering options were similar as those for the content dimension items. An additional 18 items addressed the extent to which nine forms of guidance distinguished by de Bruijn et al. (2005; also see Section 4.1) were used. Using a five-point Likert scale (from "almost never" to "very often"), teachers were asked to judge the extent of provision of guidance during the first years (9 items) and the final years of PVSE (9 items) (examples of items are "Do teachers *coach* the students' learning process?", or "Do teachers *evaluate* the students' learning process?"). From these guidance items, three guidance scales were constructed, namely, *strong guidance*, *total guidance* and *growth.* These scales provided information about the type and frequency of guidance provided by teachers in the learning environments.

**The actual subject matter**

| **A** | **B** |
|---|---|
| 1. An emphasis on functional and authentic learning<br>2. A curriculum arranged around situations and actions occurring in professional practice<br>3. Explicit attention for learning skills and problem solving | 1. A curriculum divided in clear-cut parts of course material<br>2. Theory and general skills are dealt with separately<br>3. A focus on training instrumental skills |

a What does the school prefer?
[ ] Completely A
[ ] Completely B
[ ] Closer to A than to B
[ ] Closer to B than to A

b What typifies the education in the school?
[ ] Completely A
[ ] Completely B
[ ] Closer to A than to B
[ ] Closer to B than to A

c To what extent are the elements present in the current learning environment?

| | Not at all | To some degree | To a large degree |
|---|---|---|---|
| A1<br>A2<br>A3<br>B1<br>B2<br>B3 | | | |

**Figure 4.1:** Sample questions related to the component of the actual subject matter

*Concept maps*

In order to investigate the development of student knowledge, the participants were involved in a pretest and a posttest concept map. The pretest took place at the beginning of the new project or when a new topic was introduced. The posttest was undertaken when the project or the topic that was dealt with was completed. Each student thus had to draw a concept map about the same core concept on two different occasions. Core concepts involved in the study were for example “climate”, “safety”, and “sustainable energy”. Core concepts were chosen in consultation with the participating teachers who also provided information on what the students were expected to know about the core concept in the end and thus allowed the researchers to judge the relevance of the content of the maps created by the students. Students were instructed to construct a map of all their knowledge with respect to the concept. More specifically, they were asked to: (1) note 20 to 40 concepts for themselves, (2) think about which concepts were related to each other in order to cluster them and the relative importance of the different concepts, and (3) write down everything in a concept map which they thought logical. The students were given an hour for this task. The teachers were provided with a protocol to instruct PVSE students on the creation of concept maps (see Appendix A), and students were given a form to make the concept maps on.

*Background variables*

The background variables age, gender, PVSE sector and programme, and type of education (PVSE or VET) were measured by means of a short student questionnaire. For subsequent analyses, a dummy variable was created for student gender (male=0, thus representing the baseline; female=1). An ordinal variable was created for the four PVSE programmes (ranging from 0=basic vocational programme to 3=theoretical programme). Dummy variables were also created for PVSE sector (0=Care and Welfare; 1=Technology) and for type of education (0=PVSE; 1=VET).

### 4.3.3 Data analysis

*Learning environments questionnaire*

Given that the learning environments questionnaire was expected to characterize the different learning environments in terms of various aspects of the two dimensions of competence-based education in accordance with earlier research using the questionnaire by de Bruijn et al. (2005), scales were constructed after administration of the questionnaire. As mentioned before three content scales were distinguished, namely *type*, *power,* and *customary*. Also, three guidance scales were distinguished, namely *strong guidance*, *total* *guidance* and *growth* (cf. de Bruijn & Overmaat, 2002).

Like in the study of de Bruijn and Overmaat (2002), most scales were found to have sufficient reliability (see Table 4.2). The *total guidance* scale had a Cronbach's alpha coefficient of .60. However, since Bland and Altman (1997) suggest that alpha values of .60 to .70 are sufficient for non-traditional instruments, it was decided to retain this scale for further analyses. As expected, and also in line with the study of de Bruijn and Overmaat (2002), a positive significant correlation was found between the *type* and *power* scale of the content dimension (r=.54; p=.04). Negative significant correlations were found between both the *type* and *power* scales and the control variable *customary* (r=-.51; p=.05 and r=-.72; p=.00). Regarding the guidance dimension scales, no significant correlations between the *strong guidance*, *total guidance* and *growth* scales were found.

**Table 4.2:** Average scores on the questionnaire scales and alphas

| | N | minimum | maximum | mean | SD | alpha |
|---|---|---|---|---|---|---|
| Type | 14 | 1.00 | 4.00 | 2.40 | .99 | .75 |
| Power | 14 | 1.31 | 2.92 | 2.18 | .46 | .86 |
| Customary | 14 | 1.23 | 3.00 | 1.96 | .48 | .85 |
| Strong guidance | 14 | 1.00 | 3.00 | 2.16 | .80 | .90 |
| Total guidance | 14 | 2.38 | 4.13 | 3.39 | .51 | .60 |
| Growth | 14 | 1.00 | 5.00 | 3.07 | .32 | .74 |

The average scale scores were used to calculate a total score for the learning environment on the content and guidance dimensions. Next, the average content and guidance scale scores for a learning environment were compared to the average score for the entire group in order to classify all of the learning environments. Based on this comparison (see de Bruijn et al., 2005), environments were described according to a three-point scale. Each learning environment could thus be characterized as follows.

-/- Low score on content dimension; low score on guidance dimension;

+/- or -/+ High score on content dimension; low score on guidance dimension, or: Low score on content dimension; high score on guidance dimension;

+/+ High score on content dimension; high score on guidance dimension.

*Concept maps*

As the measurement of conceptual knowledge using concept mapping is quite complicated, we developed a procedure to analyze the concept maps consisting of three phases. The procedure was derived from a study of the relevant research literature (Akinsanya & Williams, 2004; Liu, 2004; Mavers et al., 2002; Ruiz-Primo et al., 2001). The procedure to evaluate the general quality and development of the concept maps was tested in a pilot study.

In the first phase of the analysis, coders were supposed to get a thorough picture of several characteristics of students' concept maps. The pretest and posttest concept maps were analyzed by hand, using criteria derived from the literature with regard to: (1) points of interest, (2) variables, and (3) indicators (see Table 4.3). The points of interest derived from literature were operationalized in variables. These variables were linked to indicators that were directly applicable for the analysis of the maps. The variables and indicators were considered as criteria for the elaborateness and organization of the maps. At this point in the analyses, however, only a small part of the concept maps was coded this way in order to familiarize coders with the characteristics of a concept map and prepare them for the second phase. In addition, PVSE teachers had provided information on the relevance and relative importance of particular concepts students were anticipated to use in the maps prior to the creation of concept maps by the students. This was done in order to help the coders to assess the importance of the concepts used by the students.

In the second phase, the *quality* of the pretest and posttest concept maps was determined via an overall examination of the elaborateness and organization for each of the concept maps. The elaborateness involved the number of concepts (i.e., nodes), links, layers, clusters and relevance of the concepts. The organization of the concept maps was evaluated in terms of the relative importance of the concepts included, the types of connections and the clusters of concepts. Per concept map, findings for all of the criteria (based on the variables and indicators) were combined to produce an overall picture of the quality of the concept map. Successively, this overall picture for all of the pretest and posttest concept maps was rated using a five-point Likert scale (see Table 4.3). A concept map was judged to reflect a "very good quality of knowledge," for example, when a relatively large number of relevant concepts and links was used, the concepts were arranged in a logical manner (i.e., on the basis of the relative importance of the concepts and with elaborate connections), more important concepts were located closer to the centre of the concept map than less important concepts and relevant clusters of concepts were distinguished (see Figure 4.2). The criteria were given equal importance in the creation of the overall picture and were used to establish a more objective, well-founded final judgement about the quality of each concept map. It was decided to determine the overall quality of conceptual knowledge in the concept map as this overall picture was considered more representative of the quality of the conceptual knowledge than separate scores on various specific characteristics of the concept maps.

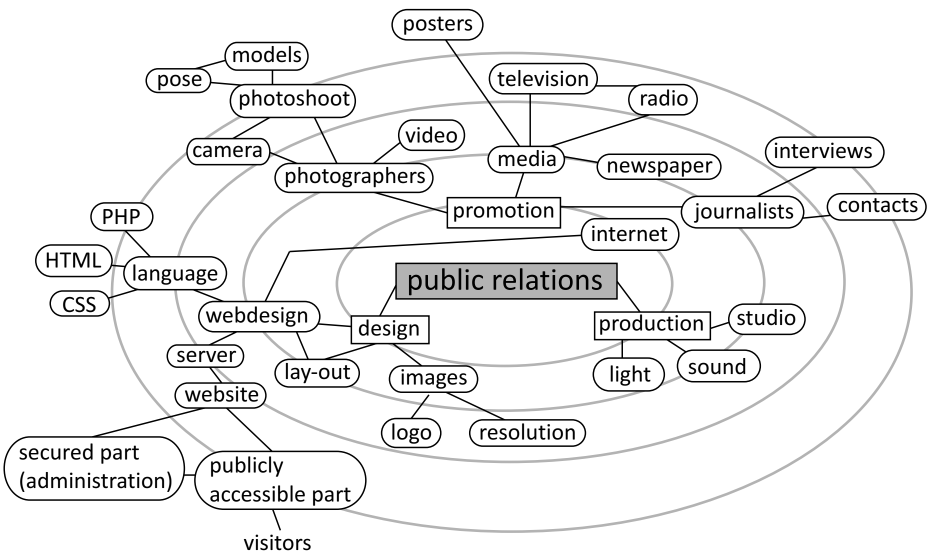


**Figure 4.2:** Sample concept map about management tasks in a music hall (transformed because of the Dutch language used in the original paper-and-pencil version)

In the third phase in order to judge *the development of knowledge* of the students, the quality of the pretest concept maps was compared to the quality of the posttest concept maps using the information gathered in the second phase of the analysis. Some of the criteria were now considered more important than others in order to create a clearer distinction between the quality of the student's pretest and posttest concept maps and thereby to gain more insight into the development of quality of students' knowledge (in terms of elaborateness and organization). More important criteria included the ratio of relevant to irrelevant concepts, the position of concepts relative to the centre of the map, types of connections and clusters of concepts. On the basis of pilot results, the elaborateness and number of links and layers in the concept maps were considered more stable and therefore less important or significant for evaluation of the development of the quality of the concept maps.

Inter-rater reliability (Cohen's Kappa) between two raters for both the judgement of the quality of the concept maps and for knowledge development together was .78 (based on 188 out of 1179 judgements).

**Table 4.3:** Coding scheme for the analysis of the concept maps

| **Phase 1** | | | |
|---|---|---|---|
| **Points of interest** | **Variables** | **Indicators** | **Analysis** |
| Concepts | Elaborateness | Number of nodes | Counting |
| | Relevance | Ratio between relevant and irrelevant nodes | Ratio between relevant and irrelevant nodes |
| | Relative importance | Position of a concept relative to the core concept | Qualitative analysis using a three-point scale (illogical - tolerably logical - logical arrangement) |
| Links | Number of links | | Counting |
| | Type of connections | | Categorization: unconnected, linear, one-centred, several-centred, network |
| Depth | Stratification | Number of layers | Maximum number of layers counting from core concept |
| Content | Clusters of concepts | Clusters with different topics distinguished in the concept map | Counting plus categorization/ determination of relevance of clusters |
| **Phase 2** | | | |
| **Final judgment (quality)** | Judgment of quality of concept map | | 1: very poor quality<br>2: poor quality<br>3: neutral<br>4: good quality<br>5: very good quality |
| **Phase 3** | | | |
| **Final judgment (knowledge development)** | Judgment of knowledge development in terms of elaborateness and organization | | 1: strong deterioration<br>2: slight deterioration<br>3: no deterioration/ no improvement<br>4: slight improvement<br>5: strong improvement |

*Analysis of the relation between the learning environment, concept maps and background variables*

Characteristics typifying the different learning environments, the quality of the concept maps and some background characteristics of the participants (i.e., age, gender, sectors in PVSE, PVSE programmes and type of education: PVSE or VET) were analyzed in connection with each other in two ways. First, raw effects were established using correlations and t-tests. Second, a hierarchical multilevel analysis of variance (using MLwiN) was conducted to investigate which differences in the development of the students' knowledge could be explained by factors at the level of the learning environment and factors at the level of the student. An empty model was created to determine how much variance was located at the two levels. A model including all of the measured variables (that is classification of the learning environment, age, gender, sectors, programmes and type of education) was tested thereafter. Those variables with a non-significant coefficient were then omitted from the model to produce a final model with only statistically significant variables. Effect sizes were computed (cf. Snijders & Bosker, 1999) as well as the amount of explained variance at the two levels of the model. In the following, the results for both the final model and the empty model will be reported.

## 4.4 Results

### 4.4.1 Quality of the concept maps and development of student knowledge in relation to PVSE learning environments

The classifications of the learning environments provided a varied picture. Some of the learning environments clearly showed elements of competence-based education; others showed no such elements but more traditional whole-class instruction. More specifically, five of the learning environments did not show many elements belonging to either the content or guidance dimensions of competence-based education; two of the learning environments showed elements of both dimensions; and seven learning environments showed either elements of the content dimension or the guidance dimension of competence-based education but not elements of both (see Table 4.4)[6].

[6] Based on personal observation of the learning environments and informal conversations with experts, teacher trainers and teachers in this field by the first author and major researcher of this study, the implementation of the elements of competence-based education appeared to vary from on the one hand relatively short projects in which authentic contexts were used to effectuate meaningful learning to, on the other hand, complete changes in the school curriculum as a whole into, for example, so-called learning areas with different subjects integrated within a particular area.

**Table 4.4:** Classification of learning environments, number of participants, number of concept maps and number of cases in which development of knowledge was measured

| Classification learning environment | N learning environments | N participants | n concept maps pretest | n concept maps posttest | n cases in which development of knowledge was measured |
|---|---|---|---|---|---|
| -- | 5 | 233 | 166 | 161 | 104 |
| +- / -+ | 7 | 488 | 277 | 207 | 140 |
| ++ | 2 | 91 | 49 | 49 | 44 |
| **Total** | **14** | **812** | **492** | **417** | **288** |

The concept mapping technique clearly portrayed both the quality and development of student knowledge. In general, the quality of the concept maps generated by the students at the posttest was significantly better than the quality of the concept maps generated at pretest (t=-6.351; p=.048; df=811; also see Table 4.5).

**Table 4.5:** Quality of the concept maps at pretest and posttest along a five-point scale

| | n | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|---|
| Pretest | 492 | 1.00 | 5.00 | 2.77 | 1.11 |
| Posttest | 417 | 1.00 | 5.00 | 3.06 | 1.06 |

For most of the students, their knowledge also developed from pretest to posttest as indicated by the different criteria in Table 4.3. As can be seen from Table 4.6, for most of the students, the conclusion can be drawn that the elaborateness and organization of their knowledge improved or strongly improved (N=150) or remained approximately the same (N=62) during the period of study (see Table 4.6).

**Table 4.6:** Judged quality of concept maps and development of knowledge along a five-point scale in percentages (with frequencies in parentheses)[a]

| | | | 1 | 2 | 3 | 4 | 5 | Total |
|---|---|---|---|---|---|---|---|---|
| | | Learning environment | | | | | | |
| Concept maps | f pretest | -- | 24.1 (40) | 27.7 (46) | 29.5 (49) | 18.7 (31) | 0 (0) | (166) |
| | | +-/-+ | 11.9 (33) | 24.5 (68) | 30.3 (84) | 26.4 (73) | 6.9 (19) | (277) |
| | | ++ | 10.2 (5) | 14.3 (7) | 36.7 (18) | 36.7 (18) | 2.0 (1) | (49) |
| | f post-test | -- | 8.1 (13) | 28.1 (35) | 30.6 (49) | 36.2 (58) | 3,1 (5) | (160) |
| | | +-/-+ | 11.1 (23) | 20.3 (42) | 43.4 (66) | 31.9 (60) | 7.7 (16) | (207) |
| | | ++ | 2.0 (1) | 12.2 (6) | 44.9 (22) | 34.7 (17) | 6.1 (3) | (49) |
| Development of knowledge | | -- | 6.4 (6) | 11.7 (11) | 21.3 (20) | 46.8 (44) | 24.5 (23) | (104) |
| | | +-/-+ | 13.6 (19) | 21.4 (30) | 24.5 (32) | 22.9 (50) | 6.4 (9) | (140) |
| | | ++ | 0 (0) | 22.7 (10) | 22.7 (10) | 47.7 (21) | 6.8 (3) | (44) |

[a] Number of students completing the concept maps; less than 812 due to absence, illness or incomplete data supply.

### 4.4.2 Relations between development of student knowledge and the two dimensions of competence-based education

The research population differed on a number of characteristics. Most importantly, the PVSE students were in learning environments which differed in the degree to which they had adopted elements of competence-based education. In those learning environments which contained more characteristics of competence-based education, the PVSE students were found to score approximately equally high on the development of knowledge scale as in those learning environments which contained fewer such characteristics. A relatively small but significant difference was found for the development of knowledge across the different learning environments when classified according to Table 4.4 and 4.6 ($r=-.143$; $p=.015$; see Table 4.7). The less learning environments were classified as competence-based, the higher the rate of development of knowledge.

Closer examination of the characteristics of the learning environments revealed some additional differences. With regard to the content dimension of the learning environments in general, a small significant difference in the development of knowledge was detected (r= -.137; p=.020; see Table 4.7). One of the variables which constitute the content dimension used to characterize the learning environments, that is *type* — or the degree to which the organization of the learning environment could be typified as potentially powerful — was negatively related to the students' development of knowledge (r=-.175; p=.003). The content variable of *power* — or the degree to which components considered powerful in advance were realized — did not relate significantly to the students' development of knowledge. And the control variable of *customary* — or a learning environment with less powerful characteristics from the perspective of competence-based learning — also exerted a small negative influence on the development of knowledge (r=-.164; p=.005).

No statistically significant correlation was found between the general guidance dimension and the development of knowledge (r=-.040; p=.496). The two guidance variables of *strong guidance* (the provision of systematic guidance, learning routes and tools) and *total guidance* (nine forms of guidance) did not relate significantly to the development of knowledge while the *growth* variable — which indicates different degrees of guidance depending upon the level of the students — was found to relate in a slightly positive but significant manner to the student's development of knowledge (r=.121; p=.040).

In sum, the content dimension used to characterize the learning environments studied here appeared to be more important than the guidance dimension. Slightly more development of knowledge was measured in learning environments with fewer characteristics of competence-based education than in those with more such characteristics. The provision of guidance in a manner which can be related to characteristics of competence-based education did not contribute to knowledge construction.

**Table 4.7:** Correlations between the development of students' knowledge, classifications of the learning environments, content characteristics of the learning environments and guidance characteristics of the learning environments

| | Development of knowledge |
|---|---|
| Overall classification of the learning environment | -.143** |
| Overall content dimension | -.137* |
| Type | -.175** |
| Power | .011 |
| Customary | -.164** |
| Overall guidance dimension | -.040 |
| Strong guidance | -.083 |
| Total guidance | .055 |
| Growth | .121* |

** p < .01; * p < .05

### 4.4.3 Relations between development of student knowledge and background variables

Students who were in the upper grades (grade 3 of PVSE or VET, 14-20 years) produced better concept maps at both pretest (t=3.928; p=.000) and posttest (t=3.145; p=.002) than students in the lower grades (grades 1 and 2, 12-14 years). The average scores at pretest were 2.61 for the lower grades and 3.00 for the upper grades. The average scores at posttest were 2.90 and 3.23, respectively. Older students were thus able to construct better concept maps than younger students but did not develop significantly more knowledge. When the PVSE and VET data are compared, the results again show the older VET students to produce better concept maps at pretest than the younger PVSE students (t=4.414; p=.000). There were no significant differences between PVSE and VET as far as the quality of the posttest and development of knowledge were concerned.

The pretest concept maps generated by students in the Technology sector were of a higher quality than those generated by students in the Care and Welfare sector (t= -6.269; p=.000; see Table 4.8). However, the development of knowledge was found to be stronger for the students in the Care and Welfare sector than for the students in the Technology sector (t=4.331; p=.000). In the Care and Welfare sector, the population of students was mostly female; in the Technology sector, the population was mostly male. When the data were analyzed according to gender, the results showed the same picture as for the associated sectors: the quality of the concept maps generated by the boys at pretest was better than the quality of the concept maps generated by the girls at pretest (t=2.076; p=.038), but the girls showed more development of knowledge than the boys ($t=-3.478$; $p=.001$).

**Table 4.8:** Average scores on the concept maps regarding sectors and gender

| | | Sector | | Gender | |
|---|---|---|---|---|---|
| | | Care and Welfare | Technology | Female | Male |
| Concept maps | Quality pretest | 2.16 | 3.09 | 2.68 | 2.89 |
| | Quality posttest | 2.97 | 3.09 | 3.16 | 2.96 |
| | Development | 3.98 | 3.10 | 3.60 | 3.11 |

No significant relations were found between the educational programme (mainly practice-oriented or theory-oriented) the students were in and the quality of the concept maps generated at either pretest or posttest. Furthermore, no significant differences in students' development of knowledge were found for the different types of programmes. That is, students' knowledge did not become better organized or more elaborate in programmes which were more practice-oriented than in programmes which were more theory-oriented.

### 4.4.4 Differences in the development of knowledge related to the level of learning environments and students

A multilevel analysis was conducted to investigate which differences could be explained by factors relating to the learning environments and the students themselves. In the empty model, the average score on the development of knowledge scale was 3.49 (range of 1-5). In the empty model, 80% of the total variance in the student's development of knowledge was related to differences among the students; the remaining variance was related to differences in the learning environments.

In the explanatory model, the amounts of variance explained by the student variables and the level of the learning environment changed slightly (see Table 4.9). The explanatory model explained 3.11% of the variance in the students' knowledge development, almost all of which pertained to the level of the learning environment. The outcomes of this model show a pattern in which the classifications of the learning environments (according to the score on the content and the guidance dimension) and student gender play a role in particular. A greater development of knowledge was detected in learning environments which possessed fewer characteristics of competence-based education. Furthermore, girls developed relatively more knowledge during the period under study than boys (an average of 0.20 more along the Likert scale). The effect sizes for these variables were relatively small with gender having the smallest effect, which was two thirds of the effect size for classification of the learning environment. Despite the small amount of variance explained by the explanatory model, a statistically significant improvement in the fit of the model was nevertheless found when compared to the empty model with a -2*loglikelihood to df ratio of 139.98 to 2 ($p<.001$).

It should be noted that most of the variance in both the empty and final explanatory models concerned student differences which were not measured in this research. Student preferences for particular types of learning activities may have played a major role, for instance. Differences at the level of the learning environment seemed to play less of a role in the development of knowledge. Nevertheless, there was a reduction of approximately one sixth of the variance on the account of learning environments in the explanatory model.

**Table 4.9:** Development of knowledge: regression coefficients (significant at .05; standard deviations in parentheses) and variance components

| | Variables | Empty model | Explanatory model | Effect size |
|---|---|---|---|---|
| | Constant | 3.49 (.13) | 3.84 (.31) | |
| | Classification learn.env. | | -.29(.18) | .15 |
| | Gender | | .20 (.10) | .09 |
| Variance | Learning environment | 19.57% | 16.47% | |
| | Student | 80.43% | 80.42% | |
| | Explained | - | 3.11 % | |
| -2*log(like) | | 2467.95 | 2334.97 | |
| Difference log (df) | | | 132.98 (2) | |

## 4.5 Conclusions and discussion

The purpose of this study was to gain insight into the development of the knowledge of students in PVSE schools which differed in the manner and extent to which they had implemented characteristics of competence-based education. The focus of the study was on the elaborateness and organization of the students' knowledge. In accordance with the results of a comparable study by de Bruijn et al. (2005), the investigated learning environments were indeed found to differ. In the majority of the learning environments (n=7), some elements of either the content or guidance dimensions of competence-based education had been adopted. In five of the learning environments, virtually no such elements had been adopted. And only two of the learning environments could be described as mainly competence-based.

Regrettably, only small differences in the students' development of knowledge were found to occur across the different learning environment classifications. In line with studies of for example Gijbels, Coertjens, Vanthournout, Struyf, and van Petegem (2008) and Nijhuis, Segers, and Gijsselaers (2005), competence-based education appeared not to have the anticipated effect on student learning. Students developed slightly more knowledge in learning environments that contained fewer characteristics of competence-based education. The fact that the intricate process of implementation of competence-based education was still evolving in many of the investigated learning environments might have complicated students' knowledge development (Windschitl, 2002).

The content dimension of the learning environment seemed to be a distinguishing characteristic for the development of knowledge. More specifically, the *type* component of the content dimension, which indicates the degree to which the organization of the learning environment could be typified as potentially powerful, appeared to negatively influence the students' learning slightly. It actually seemed that the organization of the learning environment in a manner which is associated with competence-based education effectuated less knowledge development. It is certainly possible that PVSE students find it more difficult to develop knowledge in learning environments which are less clear-cut. The manner in which learning tasks are integrated into competence-based learning environments, for example, typically creates fewer boundaries between subject areas; similarly, the adoption of authentic learning contexts can blur the boundaries between school and the real world. Perhaps PVSE students benefit from a more structured and, given their prior experiences in education, familiar organization for their education. However, the presence of learning environment characteristics which were considered less powerful beforehand, that is characteristics considered more *customary* (i.e., traditional), also negatively influenced the students' knowledge development. The results of this research suggest that a balance between elements of competence-based education and more traditional forms of education may be most suited for the organization of PVSE learning environments (cf. Kirschner et al., 2006).

The results with regard to the guidance dimension of the learning environments provided some interesting information as well. In general, the guidance dimension did not make a significant difference for the development of knowledge. However, the specific component of *growth* did influence the students' knowledge development significantly to some extent. Students developed more knowledge in learning environments where guidance was increasingly provided during the course of their educational careers. This positive correlation suggests that it might make sense to provide all forms of guidance during the entire educational trajectories of students and to carefully monitor their progress as well (cf. Hattie & Timperley, 2007).

Differences in students' development of knowledge were also analyzed with respect to student age, student gender, educational sector and educational programme. Students in the upper grades of PVSE constructed better concept maps than students in the lower grades but did not develop greater knowledge. Although the VET students also generated better pretest concept maps than PVSE students, they were comparable to the PVSE students when the development of the students' knowledge was considered. It is possible that a basic threshold level of prior knowledge is needed to generate well-organized concept maps as students must use this knowledge for the actual construction of a concept map. This basic knowledge thus has little influence on the subsequent elaboration or further organization of the students' knowledge. The development of the concept maps generated by students in the Care and Welfare sector (mostly girls) was significantly stronger than the development of the concept maps generated by students in the Technology sector (mostly boys). This is possibly due to the type of knowledge in the Technology sector where more complicated concepts which are less amenable to representation in a logical manner than many other concepts must be comprehended and recalled. All the same, in accordance with other research on gender differences in school achievement (van Langen et al., 2006), the girls in the present study showed better knowledge development and were more able to remember critical concepts than the boys. Students in the more practice-oriented programmes did not construct better concept maps than students in the more theoretical programmes and the development of knowledge also did not differ significantly across these groups. In the multilevel analysis, the explanatory model again showed the classifications of the learning environments and student gender to influence the development of knowledge. The multilevel analysis also showed most of the differences in the development of knowledge to be due to differences among the students. Nevertheless, approximately 20% of the variance occurred at the level of the learning environment, which can more effectively be influenced by teachers and curriculum developers (Scheerens, 2000). In this research, the learning environment and, more specifically, the presence of characteristics of competence-based education indeed influenced the development of knowledge, but not consistently in the direction expected.

Based on our experiences during the present research, the concept mapping technique appeared to be a suitable method to visualize the quality and development of students' knowledge in competence-based PVSE. Concept mapping is perhaps even more suited for this purpose than traditional testing as the structure of the students' knowledge (i.e., organization and elaborateness) can be investigated as well (Novak, 2002). The concept mapping technique also made it possible to investigate student knowledge across different subject areas, topics and schools, which would not have been possible using traditional tests. The arrangement of concepts and the constructed relations between them were indeed indicative of the quality of the students' knowledge. The criteria used to analyze the concept maps and their development, including the types of links, the depth of the concept maps and the clusters of concepts in the maps proved useful for the rating of a large number of maps. However, the use of these criteria in conjunction with quantification of the data also produced a loss of information when compared to, for instance, an exhaustive analysis of the content of a small number of concept maps as is often done (e.g., Liu, 2004). We nevertheless believe that the use of the present coding scheme provided as much information as possible about the quality of the concept maps, particularly in light of the large number of participants.

The results of the present study are possibly restricted, for example, by the nature of the sample. A limited number of schools were involved in the study and some of these schools had limited experiences with the implementation of elements of competence-based education. This may account for some of the disappointing results. Secondly, only teacher perceptions were taken into consideration in the study. In learning environments research, students' perceptions of the educational context are often studied because these perceptions seem to be valid and lead to higher amounts of variance explained in student outcomes (Fraser, 1998). As stated earlier, in this study teachers' perceptions of the learning environments they created were chosen because relatively new learning environment characteristics were investigated. The study of students' perceptions of these learning environments might be a useful suggestion for future research, once the students are a little more familiar with the learning environment they are in. Another suggestion for future research would be to investigate processes of knowledge development, for example trough paying attention to differences in students' cognitive learning activities conducted in different learning environments. Because of the generic nature of the concept mapping technique used to measure the development of the elaborateness and organization of knowledge in this study, little attention could be paid to the actual process of learning and integrating new concepts.

Competence-based education is intended to foster meaningful learning and therefore a better understanding of concepts and the relations between concepts. Competence-based learning environments can be described in terms of the manner in which the education is organized (i.e., a content dimension) and the manner in which the students are guided (i.e., a guidance dimension) (cf. de Bruijn et al., 2005). In the present research, the manner in which the learning environments were organized indeed had some influence on the students' development of knowledge, but not as expected. Learning environments with content characteristics of competence-based education only appeared to complicate the development of knowledge for PVSE students. Guidance characteristics, in contrast, sometimes seemed to slightly facilitate the students' knowledge development. Guidance is indeed widely acknowledged to be an essential component of competence-based education (Moreno, 2004). Schools which implement a form of competence-based education, therefore, should probably pay attention to not only the manner in which the curriculum is re-organized but also the provision of good student guidance. The provision of guidance within the context of competence-based education can possibly even be improved with the provision of more regular and diverse forms of guidance (cf. Gibbs & Simpson, 2004; Hattie & Timperley, 2007). It is then possible that under such guidance circumstances, the negative effects of the content components of competence-based education may disappear or be compensated for. Good guidance in relation to the development of knowledge and content of what has to be learned can take the form of making knowledge and the relations between learning content or the core concepts to be learned more explicit for students (cf. Entwistle & Peterson, 2004; Kirschner et al., 2006). With regard to the content dimension of competence-based education, moreover, it is recommended that a balance be sought between elements of competence-based education and elements of more traditional forms of education when organizing learning environments to foster the construction of knowledge and learning which is meaningful.

# CHAPTER 5[7]

## Learning processes of students in competence-based pre-vocational secondary education: relations between goal orientations, information processing strategies and development of knowledge

**Abstract**

The purpose of this study was to investigate relations between goal orientations, information processing strategies and development of knowledge of pre-vocational secondary education students (n=719; 14 schools). Student preferences for certain types of goals and information processing strategies were examined using questionnaires. Development of knowledge was investigated by having students create concept maps before and after a learning project. Structural and hierarchical analyses show that student preferences for mastery and performance goals positively affected their preferences for the use of deep information processing strategies. Use of surface information processing strategies negatively affected the development of knowledge.

[7] This chapter has been submitted for publication as: Koopman, M., den Brok, P., Teune, P., & Beijaard, D. *Learning processes of students in competence-based pre-vocational secondary education: relations between goal orientations, information processing strategies and development of conceptual knowledge*.

## 5.1 Introduction

In the Netherlands, approximately 60% of the students between 12 and 16 years of age are in pre-vocational secondary education (PVSE). Currently in PVSE schools, elements of competence-based education are being implemented, which implies that students have to develop and integrate knowledge, skills and attitudes (van der Sanden, 2004). This development is supported by specific characteristics of the learning environment, such as the integration of theory and practice and the use of authentic contexts as a basis for the formulation of learning tasks (de Bruijn et al., 2005). The development towards competence-based PVSE in the Netherlands aligns with an equivalent development in Vocational Education and Training (VET; PVSE prepares students for VET) and the need to better align students' interests, the school curriculum and what is needed for future professions (Biemans, Nieuwenhuis, Poell, Mulder, & Wesselink, 2004).

There are several assumptions about how students learn in competence-based education. For example, the learning environments for competence-based education are designed to appeal to intrinsic motivation on the part of the student and elicit the use of deep information processing strategies (de Bruijn et al., 2005; Hmelo-Silver, 2004; Struyven, Dochy, Janssens, & Gielen, 2006). However, these assumptions have mainly been tested in other than PVSE contexts, namely higher education contexts and, to a smaller extent, VET contexts (Entwistle & McCune, 2004; Slaats, Lodewijks, & van der Sanden, 1999; Vermunt & Vermetten, 2004). The context of competence-based PVSE differs from these contexts in that the learning tasks in the former are usually divided into smaller steps and involve a more limited freedom of choice than learning tasks in the latter. In PVSE, learning tasks are often relatively highly structured. Teachers generally play a central role in helping students to plan their learning trajectories. This is argued to be necessary because of student characteristics in PVSE: students have difficulties in regulating their learning process while working on learning tasks and the capacity for making choices about their learning route by these students is often limited (van der Neut, Teurlings, & Kools, 2005). Another feature of competence-based PVSE is that it mainly focuses on the development of skills, attitudes, and the development of basic and practice-oriented conceptual knowledge necessary to function in future working situations (van der Sanden, 2004). The relatively highly structured learning tasks may result in students mainly deploying surface processing strategies. Development of knowledge may, therefore, be affected in such a manner that less or weaker relations between concepts are made. However, little research has been conducted into the actual learning of PVSE students in competence-based learning environments and the way in which this learning may differ from learning in other contexts.

With regard to competence-based PVSE, three aspects of student learning are expected to be of particular relevance. First, the goal orientations of students are an important engine in the learning process and are the result of either intrinsic or extrinsic motives (Koopman, Teune, & Beijaard, 2008). Goal orientations reflect the type of goals students prefer to pursue and determine the effort a person is willing to put into learning (Hijzen, Boekaerts, & Vedder, 2005). However, little is known about the goal orientations of students in PVSE. Second, the goal orientations of students can be expected to influence the cognitive learning strategies or information processing strategies used by students (Limón, 2001). Information processing strategies refer to the processing of information for the attainment of students' learning goals (Vermunt, 1992). The preferences for either deep or surface processing strategies of students in PVSE have been scarcely investigated. As can be concluded from the previous paragraph, preferences of PVSE students possibly differ somewhat from students' preferences found in other contexts. Third, the types of information processing strategies used by students can influence, in turn, the quality of certain learning outcomes (Entwistle, McCune, & Walker, 2001; Entwistle & Peterson, 2004; Gerjets & Hesse, 2004; Trigwell & Prosser, 1991). With respect to learning outcomes, this research focuses on the development of knowledge. Knowledge is an essential component of competence and necessary for being able and to make adequate decisions in real-life working situations (van der Sanden, 2004). Little is known about the role of knowledge in competence-based PVSE. This learning outcome will be measured in this study by using the concept mapping technique, which is particularly suitable for the assessment of both the *organization* and the *elaborateness* of students' knowledge (cf. Akinsanya & Williams 2004; Boekaerts & Simons 2003; Novak 2002). Moreover, concept mapping also allowed for overcoming some obstacles, such as the involvement of students from different schools, domains of study, and sectors, and the fact that no standardized test is available for testing knowledge in these diverse domains.

The purpose of the present study was to investigate associations between students' goal orientations, information processing strategies and development of knowledge in the context of competence-based PVSE. The central question was: *What structural relations exist between the goal orientations, information processing strategies and development of knowledge of students in competence-based PVSE?* The answer to this question may contribute to better understanding of the cognitive learning processes of students in competence-based PVSE and provide suggestions to improve the learning environments for these students.

## 5.2 Learning processes in PVSE

As described in the Introduction, the goal orientations of students and information processing strategies they use play an important role in their learning (Vermunt & Vermetten, 2004). Both goal orientations and information processing strategies of students affect learning outcomes or, within the context of the present study, the knowledge of students. In the next sections we will therefore consider the preferences of students for certain types of goal orientations, their preferred information processing strategies and the development of their knowledge in connection with their preferred goal orientations and information processing strategies.

### 5.2.1 Goal orientations

Goal orientations of students reflect the type of goals which they prefer to pursue (van der Sanden, 2003). The goal orientation of a student can thus determine the amount of effort he or she is willing to put into a particular learning task (Driscoll, 1999). Goal orientations can range from intrinsic to extrinsic, and several attempts have been made to categorize the types of goals students can pursue when learning (e.g., Boekaerts & Simons, 2003; Bransford, Brown, & Cocking, 2000; Duda & Nicholls, 1992; Elliot & McGregor, 2001; Ng & Bereiter, 1991). For example, *mastery-oriented* goals and *performance-oriented goals* have been distinguished with, in some studies, *work-avoidance* goals as well. Mastery-oriented goals are intrinsic goals which motivate students to learn or become competent. Performance-oriented goals are more extrinsic and related to social comparison and/or striving to achieve the best relative to others. Regarding performance-oriented goals, sometimes a distinction is made between performance-approach and performance-avoidance goals (Elliot & McGregor, 2001; Harackiewicz, Barron, Pintrich, Elliot, & Thrash, 2002). Performance-approach goals are related to the demonstration of ability or trying to do better than others, and can, when combined with mastery goals, promote optimal motivation. Performance-avoidance-goals are related to the avoidance of demonstrating a lack of ability or trying not to appear worse than others, which seems to negatively affect learning outcomes (Harackiewicz et al., 2002). Work-avoidance goals are extrinsic and typically lead a student to do things well, but with as little effort as possible. Students can pursue multiple goals while conducting a learning task.

Within the context of the present study, PVSE students are expected to have a preference for one or more of the aforementioned goal orientations, namely: (a) a mastery orientation, (b) a performance orientation, and/or (c) a work-avoidance orientation. The importance of the goal orientations of students in their learning processes has received considerable empirical support (Dweck, 1986; Hijzen et al., 2005; Hubers, 2003). The goal orientations of students have been found to influence not only their motivation to learn but also the information processing strategies they adopt and the extent to which they integrate their developing knowledge, skills and attitudes (van der Sanden, 2004). There is some empirical support for the claim that mostly intrinsic mastery-oriented goals evoke the adoption of deeper information processing strategies and thereby lead to better learning results than more extrinsic performance or work-avoidance goals with their focus on pure knowledge acquisition (Ausubel, 1968; Kaldeway, 2006; Novak, 2002; Rozendaal, 2002). Students in competence-based learning environments are therefore encouraged to develop intrinsic learning goals or mastery-oriented goal orientations (Boekaerts, de Koning, & Vedder, 2006). In the present research on the learning of the students in competence-based PVSE, a stronger mastery orientation (in contrast to performance and work avoidance orientations) is hypothesized to lead to the use of deeper information processing strategies (Coutinho & Neuman, 2008).

### 5.2.2 Information processing strategies

Research on learning processes often focuses on cognitive processes and information processing strategies (Entwistle & McCune, 2004; Vermunt & Vermetten, 2004). Information processing strategies are the particular combinations of cognitive learning activities which directly refer to the processing of information for the attainment of particular learning goals (Vermunt, 1992). In studies on information processing strategies, a distinction is often made between surface (i.e., reproductive) processing and deep processing (i.e., meaningful learning or learning aimed at improvement of understanding) (cf. Chin & Brown, 2000; Marton & Säljö, 1976; Novak, 2002; Rozendaal, 2002). Learners who adopt deep processing strategies engage in such learning activities as: (a) relating and structuring of learning content, (b) critical processing of information, and (c) concrete processing in the form, for instance, of making mental depictions of the information provided or linking information to outside school experiences. Conversely, learners who adopt surface processing strategies engage in mostly memorizing and repeating the learning content and analyzing learning tasks (dividing the learning content into smaller parts and performing tasks in a more or less prescribed order).

The *preferences* of students and other learners for particular types of information processing have been found to affect the development of knowledge. As might be expected, preferences for deep processing strategies appear to be superior to surface processing strategies (Struyven et al., 2006). Students that prefer deep processing strategies show a clear interest in understanding the meaning of the learning content and a focus on relating parts of learning content to each other and the linking of the new information to prior knowledge and experiences (Chin & Brown, 2000). Such learners are more effective when it comes to the development of knowledge than surface learners who tend to memorize separate facts and are merely able to reproduce these facts or concepts and procedures as a result of rote learning. In contrast to deep learners, surface learners often isolate educational learning content from their other tasks and experiences outside school. Consequently, in the present study it is expected that the use of deeper information processing strategies by PVSE students will result in greater development of knowledge and a better quality of knowledge than the use of more superficial information processing strategies (Vermunt & Vermetten, 2004). In addition, the adoption of particular types of information processing strategies can be affected by the goal orientations of students and the types of underlying motives (i.e., intrinsic or extrinsic motives) which they have (Biggs, 1994; Chin & Brown, 2000; Dweck, Mangels, & Good, 2004; Prawat, 1989; Rozendaal, 2002). In other words, the information processing strategies adopted by students can be expected to mediate the associations between their goal orientations and development of knowledge.

### 5.2.3 Development of knowledge

As argued in Section 5.1, in competence-based PVSE the development and integration of knowledge is strived for. Learning skills and attitudes occupy a more central place than the development of knowledge in competence-based education when compared to traditional education. However, the construction of knowledge is still an important goal for students in order to become competent and clearly qualified professionals (Bereiter, 1997; Everwijn, Bomers, & Knubben, 1993). Obviously, knowledge is required for PVSE students to function adequately in working situations (Eraut, 1994; Glaser & Bassok, 1989). Knowledge is generally necessary for students to reason and to make decisions. In competence-based education, knowledge is not so much factual knowledge but, especially in PVSE, it is supposed to have practical importance and expected to be personal and authentic (cf. Eraut, 1994). In PVSE students are encouraged to develop practice-oriented knowledge that can be applied in learning tasks similar to situations and actions occurring in professional practice (de Bruijn et al., 2005). In line with contemporary theories of the development of knowledge (Novak, 2002), we assume that students' knowledge is stored in networks of concepts. When deep information processing strategies are deployed, new concepts and meanings can be integrated into already existing cognitive structures; these structures can be adapted or even restructured as a result of such integration. Rather than solely drilling the content of learning and practicing with the content, knowledge is actively constructed by learners (Birenbaum, 2003). As argued it remains to be seen if PVSE students actually deploy deep processing strategies to a large degree. Based on the small amount of research available on information processing in PVSE, these students are expected to be inclined to also or mainly execute surface processing strategies (van der Neut et al., 2005; Rozendaal, 2002).

The knowledge that is constructed by students deploying deep processing strategies may be organized in theory-like structures which are extensive, flexible and coherently organized around core concepts (Hmelo-Silver, 2004; Novak, 2002; Vosniadou, 2007a; Vosniadou, 2007b). The development of knowledge can be expected to manifest itself as changes in the *elaborateness* and *organization* of such knowledge (Dochy, Segers, van de Bossche, & Gijbels, 2003; Glaser & Bassok, 1989; Scardamalia & Bereiter, 2006). More elaborate and better organized knowledge, in turn, facilitates the retrievability of knowledge (Prawat, 1989; van Zele, Lenaerts, & Wieme, 2004). Enhanced knowledge retrieval affects the ability of students to apply knowledge and skills in new learning contexts (Gijbels, Dochy, van de Bossche, & Segers, 2005; Hmelo-Silver, 2004). In research in other contexts, students with more elaborate and well-organized knowledge structures have been found to be relatively better at the recognition of patterns, generation of explanations and statement of arguments in addition to the drawing of analogies between problems. Given their relatively higher level of conceptual understanding and expertise, such students are also able to quickly identify what is relevant in various situations (Bransford et al., 2000).

### 5.2.4 Conceptual model and specific research questions

Figure 5.1 outlines the conceptual model which constitutes the starting point for the present study. In the conceptual model, expected relations between PVSE students' goal orientations, information processing strategies, and development of knowledge are displayed. These relations were derived from the literature about research into comparable variables in different contexts, often using similar or more elaborate models (e.g., Entwistle & McCune, 2004; Entwistle & Peterson, 2004; Gerjets & Hesse, 2004; Rozendaal, 2002; Slaats et al., 1999). There is a reasonable amount of evidence that having mastery-oriented goals generally results in the execution of deep processing strategies and in high-quality learning outcomes, such as well-structured knowledge (Rozendaal, 2002; Vermunt & Vermetten, 2004). The relation between performance-oriented goals and information processing strategies and learning outcomes seems somewhat less supported. In some studies positive relations were found between performance-oriented (approach) goals and learning (Harackiewicz et al., 2002), while in other studies negative relations were found between performance-oriented (avoidance) goals and learning (Midgley, Kaplan, & Middleton, 2001). Work-avoidance goals generally appeared to be related to the execution of surface processing strategies and to result in lower-quality learning outcomes (Duda & Nicholls, 1992; Harackiewicz, Barron, Carter, Lehto, & Elliot, 1997). Relatively strong evidence has been found for the relation between preferences for either deep or surface processing strategies and learning outcomes in other contexts than PVSE (see reviews of Blumberg, 2000; Vermunt & Vermetten, 2004), with deep processing having a positive influence and surface processing having a negative influence on learning outcomes.

For the moment, in PVSE largely the same relations are expected to emerge. Mastery-oriented goals are expected to be related to preferences for deep processing, whereas work-avoidance goals - and possibly also performance-oriented goals - are expected to elicit surface processing. Deep processing is expected to result in more elaborate and better organized knowledge than surface processing.

However, this study is carried out in a different type of education and takes into account PVSE students' characteristics. Possibly, the relations will have different magnitudes (in terms of effect sizes) and/or divergent relations will be found. For example, PVSE students may have differing preferences for information processing strategies as a result of the highly structured learning tasks they are confronted with. Hence, it is not entirely clear how the variables will be related in competence-based PVSE. Based on the model, the central question of this study can be divided into the following two more specific research questions:

(a) Which goal orientations and information processing strategies do PVSE students prefer and to what extent does students' development of knowledge occur in competence-based PVSE?

(b) How do the goal orientations, information processing strategies and development of knowledge of PVSE students relate?

The novelty of this study originates from the fact that cognitive learning processes of students in competence-based PVSE have been scarcely investigated. As such, this study will contribute to designing learning environments that elicit intrinsic goal orientations and foster deep learning and development of knowledge.

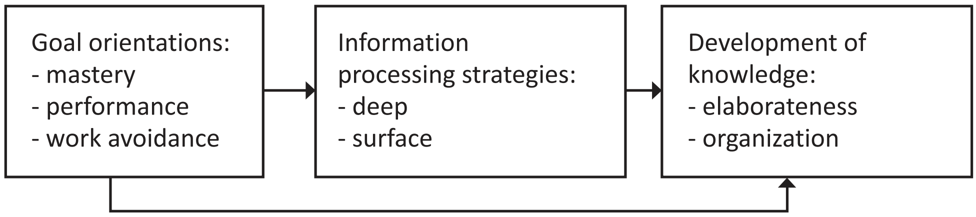


**Figure 5.1:** Conceptual model

## 5.3 Method

### 5.3.1 Participants

Students (n=719) from 14 different schools in the southern part of the Netherlands were involved in the study. A convenience sample across different PVSE sectors was taken with the criterion for the selection of the schools being the presence of project-based learning environments. The students were in the first, second or third years of PVSE (age 12-16; 53% male and 47% female). Third-year students were mainly from the sectors Care & Welfare or Technology (see Table 5.1)[8].

**Table 5.1:** Participants

| Year | Sector | n schools | n students |
|---|---|---|---|
| 1 | Technology | 1 | 41 |
| 1+2 | Technology | 1 | 49 |
| 1+2 | Undecided[a] | 2 | 308 |
| 2 | Technology | 1 | 17 |
| 2 | Care & Welfare | 2 | 128 |
| 3 | Technology | 1 | 14 |
| 3 | Care & Welfare | 2 | 53 |
| 3 | Undecided | 4 | 109 |
| **Total** | | **14** | **719** |

[a] Most first- and second-year PVSE-students and some third-year students had not chosen a sector yet and are therefore labelled as Undecided here

[8] Dutch PVSE consists of four programmes in four sectors (Care and Welfare, Technology, Business and Agriculture). The four programmes differ in the degree of difficulty and in the ratio of theoretical to practical subjects. For example, in the basic vocational and the middle management vocational programme (the most practice-oriented programmes) students mainly follow vocational subjects on a basic level of difficulty. In the combined and theoretical programmes (the more theoretical oriented programmes) students are mainly engaged in general subjects on a higher level of difficulty.

### 5.3.2 Competence-based projects

Based on information provided about the schools by the teachers involved, it was concluded that all of the schools had implemented characteristics of competence-based education to a greater or lesser extent. This pertained to the integration of theory and practice and the adoption of authentic contexts as the basis for the elicitation of self-directed learning. In some schools, students experienced a nearly perfect implementation of characteristics of competence-based education, with a curriculum that was sorted around situations and actions derived from professional practice and with authentic forms of assessment (for example performance assessment and portfolio). In other schools only some elements of competence-based education were implemented, such as an emphasis on real-life learning, but there the curriculum was built in a more linear manner. In accordance with the characteristics of competence-based education, these schools often created rich and collaborative learning environments. The implementation of competence-based education in PVSE perhaps differed somewhat from more familiar forms of competence-based education. As already mentioned, in these PVSE schools the learning tasks were relatively highly structured. Also, teachers played a relatively large role in helping the students plan their learning trajectories. The content of the environments investigated varied from school to school but all of them involved a project devoted to the introduction of a new topic. The development of knowledge played a role in all of the projects and a specific core concept could also be distinguished, which was necessary as concept maps had to be made by the students as part of the present study (see Section 5.3.3). All of the investigated projects lasted anywhere from 20 to 30 hours across a period of eight to ten weeks.

### 5.3.3 Instruments

*Goal orientations*

The preferences of the students for particular types of goal orientations were investigated using a goal orientations questionnaire which consisted of 29 items rated along a five-point Likert scale (Duda & Nicholls, 1992). For each item, the students had to indicate the extent to which they felt satisfied with that specific aspect of the project (see Table 5.2). That is, the students were instructed to keep the specific context of the project in mind while responding to the questionnaire items. Given that the goal orientations questionnaire was expected to distinguish between mastery, performance and work-avoidance orientations, the scales reflecting these orientations were tested for unidimensionality and overlap after administration of the questionnaire. For each scale, the Cronbach's alpha was determined and, in order to improve the reliability of the work-avoidance scale, one item was deleted. Cronbach's alphas were .94 for mastery, .96 for performance and .93 for work avoidance, which were comparable to (or higher than) the alphas found in the original study using this questionnaire (.89 for mastery; .89 for performance; .73 for work avoidance).

To assess the construct validity of the goal orientations questionnaire, a confirmatory factor analysis (with Mplus, Muthén & Muthén, 1999) was performed on the scales of the questionnaire to test its structure. In order to improve model fit, random correlations between items of different scales were specified provided that they emerged between items of the same scale. A reasonable fit was found according to some fit indices ($\chi^2$=923.30 with df=331 (p=.00); RMSEA=.05), but some room for improvement was suggested as well by others (CFI=.90; TLI=.89; SRMR=.07). The fact that the fit was only reasonable may have been caused by the fact that the PVSE context represents a different context than the context for which the questionnaire was originally designed. Possibly, limited reading skills and conceptual level may have contributed to a less pronounced structure than was expected. However, each of the factor loadings (ranging between .241 and .715) was statistically significant (t-value>1.96) and factors explained a considerable amount of variance in items (between 5.8 and 51.2 percent, with most items having a percentage of explained variance of approximately 40 %).

In keeping with the results of prior research using similar goal orientations questionnaires (Koopman, Teune, & Beijaard, 2008; Coutinho & Neuman, 2008; Duda & Nicholls, 1992; Pintrich, Conley, & Kempler, 2003), correlations between the scales were detected in the present study. Correlations of .56 between mastery and performance, .53 between performance and work avoidance, and .20 between mastery and work avoidance were found. In the Duda and Nicholls study (1992), for example, correlations of .21 between mastery and performance, .19 between performance and work avoidance and .55 between mastery and work avoidance were found. However, the relatively moderate correlation coefficients of .20 to .56 show the scales to be sufficiently independent. Subsequently, average scores on the different scales were calculated per student.

*Information processing strategies*

The use of deep or surface processing strategies by the students was investigated with an adapted version of the Learning Styles Inventory from Vermunt et al. (Vermunt, Bouhuijs, Piccarelli, Kicken, & Andree, 2006). Only the scales on information processing were used, which meant that 25 items were rated along a five-point Likert scale. The students had to indicate the extent to which they preferred each of the processing strategies indicated by the 25 items (see Table 5.2). The students were instructed to respond with respect to their task-specific learning behaviour during the specific competence-based project. When the reliability of the information processing questionnaire was analyzed, it was decided to omit two items which were supposed to reflect the use of surface processing strategies in order to improve the quality of that scale. The Cronbach's alphas were .82 for deep processing and .73 for surface processing. In the original study using the questionnaire (Vermunt, 1992), alphas of .67 and .83 were found respectively.

To assess the construct validity of the information processing questionnaire, a confirmatory factor analysis was performed on the scales of the questionnaire to test its structure. A reasonable fit for all model indices was found ($\chi^2$=327.57 with df=197 (p=.00); CFI=.94; TLI=.92; RMSEA=.04; SRMR=.05). Factor loadings were statistically significant (and ranged between .240 and .677) and the factors explained a considerable amount of variance in items (between 5.8 and 45.8 percent with most items having a percentage of explained variance of approximately 30 %). In line with the results of earlier research on students' information processing (Trigwell & Prosser, 1991), a significant positive correlation of .61 was found between the questionnaire scales. In a study using the original questionnaire also a correlation of .61 was found between the two scales (Boyle, Duffy, & Dunleavy, 2003). Similar to the goal orientation scales, this correlation was not considered problematic. The correlation that was found in this study does not conflict with the unique character of PVSE, in which learning tasks are presented in a highly structured manner that may elicit the use of both deep and surface processing. Next, average scores per student were calculated for the two information processing scales.

**Table 5.2:** Instruments and content of the instruments

| Instrument | Length | Scale | Sample item |
|---|---|---|---|
| Goal orientations questionnaire | 29 items, 5-point Likert scale | Mastery (10 items) | As a student, I feel satisfied when I learn something interesting |
| | | Performance (10 items) | As a student, I feel satisfied when I do better than other students |
| | | Work-avoidance (9 items) | As a student, I feel satisfied when I don't have to do much work but get a good mark anyway |
| Information processing strategies questionnaire | 25 items, 5-point Likert scale | Deep processing strategies (10 items) | When I read something, I wonder if it's true or not |
| | | Surface processing strategies (15 items) | I learn lists of important things by heart |

*Development of knowledge*

In order to investigate the development of the students' knowledge, concept maps were drawn individually by the students prior to the start of the competence-based project and upon completion of the project. On both occasions, students had to draw a concept map for the core concept in the project (Novak, 2002). In contrast to the measurement of knowledge using traditional tests, concept mapping can be used to visualize the *organization* of the individual's knowledge and the *elaborateness* of this knowledge (cf. Akinsanya & Williams, 2004; Novak, 2002). Given the widely differing topics and characters of the competence-based projects it was impossible to compare the development of knowledge across the different groups of students involved in such projects using a standardized test (Stoddart, Abrams, Gasper, & Canaday, 2000). Research shows that concept mapping appears to be particularly well-suited for measurement of the improvement or deterioration in the elaborateness and organization of knowledge (Meijer, 1999; Buitink, 2009).

Students were asked to construct a map on the basis of all their knowledge of the core concept. In doing this, they were asked: (1) to note between 20 to 40 concepts related to the core concept, (2) to think about which concepts were related to each other in order to be able to cluster them and consider the relative importance of the different concepts in order to place the more important concepts closer to the centre of the concept map, and (3) to write down everything in the concept map in a manner which they considered logical, including any additional information they might have.

As the measurement of knowledge using concept mapping is quite complicated, we developed the following procedure to analyze the concept maps. Prior to the creation of the concept maps, PVSE teachers provided the researchers with information on the relevance and relative importance of various concepts related to the core concepts in the competence-based projects in order for the researchers to be able to better assess the students' concept maps. In the first phase of the analysis, the coders were supposed to get a thorough picture of several characteristics of the students' concept maps. The characteristics of pretest and posttest concept maps were scored by hand by means of a coding scheme using as guidelines the criteria (i.e., indicators; see the third column in Table 5.3) which were derived from previous studies in which the analysis of concept maps is described (Liu, 2004; Mavers, Somekh, & Resorick, 2002; Ruiz-Primo, Schultz, Li, & Shavelson, 2001). At this point in the analysis, a small part of the concept maps was coded this way in order to prepare the coders for the more global analysis in the second phase.

**Table 5.3:** Coding scheme for the analysis of concept maps

| Points of interest | Variables | Indicators | Analysis |
|---|---|---|---|
| Concepts | Elaborateness | Number of nodes | Counting |
| | Relevance | Ratio between relevant and irrelevant nodes | Ratio between relevant and irrelevant nodes |
| | Relative importance | Position of a concept relative to the core concept | Qualitative analysis using a three-point scale (illogical - tolerably logical - logical arrangement) |
| Links | Number of links | | Counting |
| | Type of connections | | Categorization: unconnected, linear, one-centred, several-centred, network |
| Depth | Stratification | Number of layers | Maximum number of layers counting from core concept |
| Content | Clusters of concepts | Clusters with different topics distinguished in the concept map | Counting plus categorization/ determination of relevance of the clusters |

In the second phase, the *overall quality* of all the pretest and posttest concept maps was determined via examination of the various indicators for the degree of elaborateness and organization for each of the concept maps. Elaborateness was evaluated in terms of the number of concepts (i.e., nodes), links, layers and clusters within the concept map and the relevance of the concepts. Organization was evaluated in terms of the relative importance of the concepts included, the types of connections and the clusters of concepts.

Per concept map, the findings for all of the indicators were next combined to produce an overall picture of the quality of the concept map. An overall rating of the quality of the knowledge in each pretest and posttest concept map was assigned using a five-point Likert-scale (1=very poor quality of knowledge; 2=poor quality; 3=neutral; 4=good quality; 5=very good quality of knowledge). A concept was judged to reflect a “very good quality of knowledge”, for example, when a relatively large number of relevant concepts and links was used, the concepts were arranged in a logical manner (i.e., on the basis of the relative importance of the concepts and with elaborate connections), more important concepts were located closer to the centre of the concept map than less important concepts, and relevant clusters of concepts were distinguished. It was decided to combine the scores for the various indicators for a concept map to determine the overall quality of the knowledge reflected in the concept map as the overall picture was considered more representative of the quality of the knowledge than the separate scores on indicators. Qualitative and quantitative indicators could be combined for the assignment of an overall quality rating. Use of a five-point rating scale appeared to be justified as a correlation analysis of the separate indicators showed all of the indicators to contribute significantly to the overall quality ratings assigned to the concept maps.

A second coder also coded a random selection of the concept maps. The inter-rater reliability (Cohen’s Kappa) for the overall judgements of the quality of the concept maps was found on the basis of 188 out of 1179 judgements to be .78.

### 5.3.4 Design and procedure

Data collection was undertaken across the period of eight to ten weeks in which the projects were conducted within the schools. In the first week of each project, after the students had briefly familiarized themselves with the subject, the goal orientations questionnaire was administered. Thereafter, the students created a concept map to assess their knowledge. The students were given an hour to make their concept map. Immediately following completion of the project, the students were asked to create a second concept map for the same core concept as the first concept map. They were again given an hour to make the concept maps. At this stage in the collection of the data, the information processing strategies questionnaire was administered. An overview of the sequence of data collection can be found in Table 5.4. The number of students involved in the data collection turned out to be smaller than 719. This was mostly due to the schools not being able to schedule all the necessary research activities or the absence/illness of individual students.

**Table 5.4:** Time course for data collection and number of participants per instrument[a]

| Instrument | Time course | n |
|---|---|---|
| Goal orientations questionnaire | First week of project | 554 |
| Information processing strategies questionnaire | End of project | 341 |
| Concept mapping technique | Pretest: first week of project | 403 |
| | Posttest: end of project | 330 |

[a]Number of students completing the concept maps; less than 719 due to absence, illness or incomplete data supply.

### 5.3.5 Data analysis

The outcomes regarding goal orientations, preferences for particular processing strategies and the degree of knowledge development were used to create a structural model of the relations between these aspects of students' competence-based learning (using Mplus, Muthén & Muthén, 1999). Missing values were estimated using the SPSS missing value analysis (MVA) command (cf. Trautwein & Lüdtke, 2009). This procedure estimates missing values on the basis of all other variables available for the sample and the individual respondent. Due to the large number of items compared to the number of respondents, it was decided to directly use scale scores as latent variables in the model. Direct paths were formulated between each of the goal orientation scales and information processing scales. In light of the fact that students can use both types of processing strategies while performing a given learning task (e.g., Boyle et al., 2003; Gijbels et al., 2008), the two information processing scales were expected to be related to at least some extent. Paths were assumed between all the questionnaire scales and the posttest concept map score. The theoretical starting model did not show a good fit for the data ($\chi^2$= 51.43 with df=3 (p=.00); CFI=.75; TLI=-.24; RMSEA=.15 and SRMR=.05; see Table 5.5, model 1). The Root Mean Square Error of Approximation, the Tucker-Lewis Index, the Comparative Fit Index and the Chi-square statistics showed considerable room for improvement. Only significant paths were included in the next model (Table 5.5, model 2), and fit indices were used to investigate whether the model provided an adequate fit for the data or not. Next, we also used the MI (modification index) to incorporate additional paths into the model until no further improvement was reached (Table 5.5, model 3). They concerned the relations between and within the boxes of Figure 5.1. The final structural model provided an adequate fit (Table 5.5, model 4). The standardized path coefficients and effect sizes (Cohen's effect size for correlation) were therefore estimated for this model (Kline, 2005).

**Table 5.5:** Structural models tested in consecutive steps in the analyses

| Model | Description | $\chi^2$ (df), p-value | CFI | TLI | RMSEA | SRMR |
|---|---|---|---|---|---|---|
| 1 | Theoretical starting model | 51.43 (3), .00 | .75 | -.24 | .15 | .05 |
| 2 | Model 2, with non-significant path coefficients deleted between mastery & posttest, work avoidance & posttest, deep processing strategies & posttest | 52.48 (6), .00 | .76 | .40 | .10 | .05 |
| 3 | Model 3, with a correlation added between deep & surface processing strategies | 4.79 (5), .44 | 1.00 | 1.00 | .00 | .02 |
| 4 | Model 4, incorporating an additional path between pretest and deep processing strategies (using MI) | 1.58 (4), .81 | 1.00 | 1.00 | .00 | .01 |

## 5.4 Results

### 5.4.1 Preferred goal orientations, information processing strategies and development of knowledge

In order to gain insight into the results for the two questionnaires and the development of knowledge of the PVSE students, average scale scores were calculated using SPSS (see Table 5.6). In addition, the correlations between the various questionnaire scales and the pretest and posttest concept maps were calculated (see Table 5.7).

With regard to the goal orientations of the students, it can be concluded that most students preferred a mastery orientation with a mean score of 3.56, which was 64% of the maximal possible score. Trying to perform the best (i.e., a performance orientation) or attaining sufficient grades without much effort (i.e., a work avoidance orientation) showed relatively lower mean scores with 50% and 59% of the maximal possible score, respectively. With regard to the information processing strategies of the students, surface processing strategies were preferred most with a mean score of 3.30, which was 58% of the maximal possible score. The concept mapping technique provided insight into the quality of the knowledge of the students and the development of this. As might be expected, the posttest quality of the students' concept maps was significantly better than the pretest quality (F=4.93; p=.001). The mean score at the beginning of the project was 41% of the maximal possible score while the mean score after completion of the project was 52% of the maximal possible score, which showed an increase of 11%. A large amount of variance was found for the knowledge of the students; some variance was found for the goal orientation scale scores; and relatively little variance was found for the information processing scale scores.

**Table 5.6:** Average scores on questionnaire scales and concept maps

| | N | Min. | Max. | Mean | SD |
|---|---|---|---|---|---|
| Mastery | 554 | 1.00 | 5.00 | 3.56 | .70 |
| Performance | 554 | 1.00 | 5.00 | 3.03 | .73 |
| Work avoidance | 554 | 1.00 | 5.00 | 3.36 | .78 |
| Deep processing strategies | 341 | 1.10 | 4.60 | 2.71 | .64 |
| Surface processing strategies | 341 | 1.08 | 4.75 | 3.30 | .57 |
| Pretest concept map | 403 | 1 | 5 | 2.64 | 1.12 |
| Posttest concept map | 330 | 1 | 5 | 3.06 | 1.08 |

Correlation analysis of the relations between goal orientations and information processing strategies showed mastery orientation and performance orientation scales to be positively related to both deep processing strategies and surface processing strategies (mastery orientation and deep processing strategies: r=.25; p=.00; mastery orientation and surface processing strategies: r=.30; p=.00; performance orientation and deep processing strategies: r=.20; p=.00; performance orientation and surface processing strategies: r=.15; p= 01; see Table 5.7). In contrast, the work-avoidance scale was negatively related to both deep processing strategies and surface processing strategies. However, none of these correlations were statistically significant. None of the relations between goal orientations and the concept map measures were statistically significant. With regard to the relations between deep or surface information processing strategies and the concept map measures, again no significant relations were found. The scores on the pretest and posttest concept maps were positively related (r=.28; p=.00).

**Table 5.7:** Correlations between students' goal orientations, information processing strategies, and the pretest and posttest concept maps

| | Mastery | Perfor-mance | Work avoid. | Deep processing strategies | Surface processing strategies | Pretest concept maps | Posttest concept maps |
|---|---|---|---|---|---|---|---|
| Mastery | - | | | | | | |
| Perfor-mance | .53** | - | | | | | |
| Work avoidance | .21** | .45** | - | | | | |
| Deep processing strategies | .25** | .20** | -.04 | - | | | |
| Surface processing strategies | .30** | .15* | -.08 | .48** | - | | |
| Pretest concept maps | .02 | .05 | .04 | -.04 | .01 | - | |
| Posttest concept maps | .02 | .09 | .11 | .06 | -.05 | .28** | - |

** p < .01
* p < .05

### 5.4.2 Relations between goal orientations, information processing strategies and development of knowledge: a structural model

In Figure 5.2, the final structural model as well as the standardized path coefficients are depicted. In Table 5.8 the direct, the indirect and total effects based upon Figure 5.2 are displayed (cf. Verschuren, 1991).

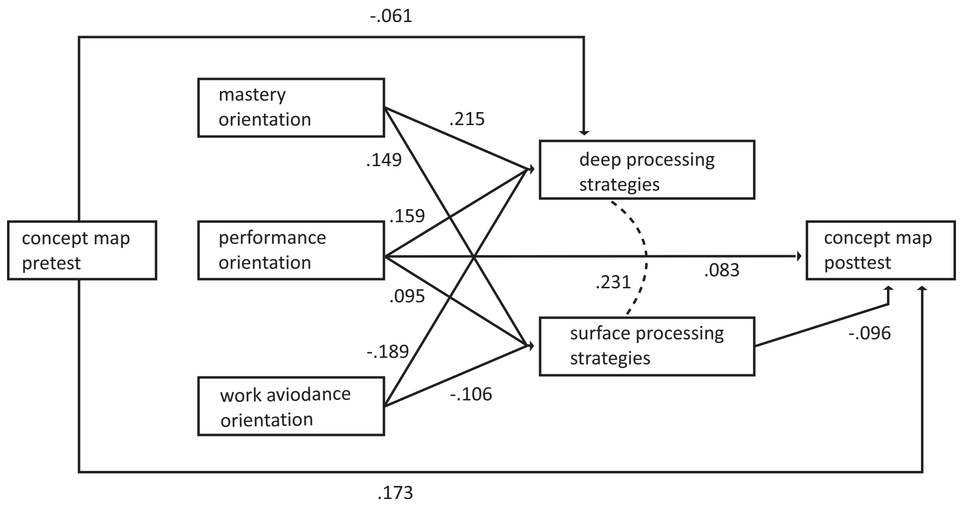


**Figure 5.2:** Structural model of significant paths between measured variables

**Table 5.8:** Direct, indirect and total effects based on Figure 5.2

| Variable | Deep processing | | | Surface processing | | | Posttest concept map | | |
|---|---|---|---|---|---|---|---|---|---|
| | Direct | Indirect | Total | Direct | Indirect | Total | Direct | Indirect | Total |
| Pretest | -.061 | - | -.061 | - | - | - | .173 | - | .173 |
| Mastery | .215 | - | .215 | .194 | - | .194 | - | -.019 | -.019 |
| Perfor-mance | .159 | - | .159 | .095 | - | .095 | .083 | -.009 | .074 |
| Work avoid. | -.189 | - | -.189 | -.106 | - | -.106 | - | .010 | .010 |
| Deep proc. | - | - | - | .231 | - | .231 | - | - | - |
| Surface proc. | - | - | - | - | - | - | -.096 | - | -.096 |

While several significant relations were found in the structural model, the effect sizes for these paths were all found to be rather small. A complex picture thus emerged in which direct and indirect effects influenced preferences for deep processing, preferences for surface processing and the quality of the posttest concept maps.

Small, yet significant relations occurred between the goal orientations preferred by the students and their preferred information processing strategies. Preferences for a mastery orientation and a performance orientation positively influenced the students' preferences for both deep and surface information processing strategies. Preferences for a mastery orientation exerted the largest effect on the information processing strategies of the students. The opposite was found for a work avoidance orientation. Avoidance of work had a direct negative influence upon the preferences of the students for both deep and surface processing strategies. The total for the direct and indirect effects of the three types of goal orientations on deep processing strategies were .215 for a mastery orientation, .159 for a performance orientation and -.189 for a work avoidance orientation. The total for the direct and indirect effects of the goal orientations of the students on surface processing strategies were .194 for a mastery orientation, .095 for a performance orientation and -.106 for a work avoidance orientation. A significant positive relation was found between the students' preferences for surface processing strategies and their preferences for deep processing strategies. It is thus possible that a certain amount of surface processing must occur for deep processing to occur or the other way around. The quality of the pretest concept maps was negatively related to the preferences of the students for deep processing strategies. This path showed the smallest effect size, however. In the end, the model explained 10.8% of the variance in the preferences of the students for deep processing strategies and 6.1% of the variance in the preferences of the students for surface processing strategies.

With regard to the quality of the posttest concept maps, small but significant relations were again found. A positive relation was found between the quality of the concept maps made in the pretest and the posttest. This shows the degree of organization and elaborateness for the knowledge of the students after completion of the competence-based learning project to be determined at least in part by the quality of their knowledge before the project started. The effect size for this path was the highest of all effect sizes and 1.5 to 2 times larger than the effect sizes found for the other associations with the posttest concept map scores. A direct relation was also found between a performance goal orientation and the quality of the students' knowledge during the posttest. This relation shows a preference for a performance orientation to positively affect the quality of the students' posttest concept maps. Preferences for surface processing strategies produced a direct negative effect upon the quality of the students' knowledge at posttest. A preference for deep processing strategies exerted no direct effect upon the quality of the students' knowledge during the posttest. The preferences for the three types of goal orientations further showed *indirect* effects upon the quality of the posttest concept maps of the students as well. A preference for a mastery orientation showed a small but negative indirect effect upon the quality of the posttest concept maps (-.019). A preference for a performance orientation showed a negative indirect effect (-.009) but a positive total effect (.074) upon the quality of the posttest concept maps. Finally, a preference for a work avoidance orientation showed a small but indirect positive effect upon the quality of the students' posttest concept maps (.010). In the end, the model explained 4.4% of the variance in the quality of the students' concept maps after completion of the various competence-based learning projects.

## 5.5 Conclusions and discussion

The central question in this study concerned the relations between the goal orientations, information processing strategies and development of knowledge of students in competence-based PVSE. Based on the relatively weak relations, one must be reserved in drawing conclusions, but the results suggest that with regard to the influence of particular goal orientations on the information processing strategies preferred by the students, the mastery and performance orientations were positively related to preferences for both deep and surface processing strategies whereas a work avoidance orientation was negatively related to such preferences. These results were largely in line with our expectations. Remarkably, however, a performance goal orientation exerted a direct positive effect upon the quality of the students' posttest concept maps. Comparable results were found by Harackiewicz et al. (2002). It is likely that performance-oriented students want to achieve well and thus tried their best during the concept map posttest. If a retention measure had been administered three months later, for example, one could wonder if these effects would persist.

A significant relation was found between deep and surface processing strategies. The greater the preference for surface processing strategies, the greater the preference for deep processing strategies as well. This interrelation could be caused by the characteristics of the learning environments which the PVSE students were in. Given that most PVSE schools provide highly structured tasks to help their students regulate their learning processes, the use of surface strategies was probably stimulated. Stated differently, we suspect that the expectations of teachers with regard to the learning of their PVSE students and the specific characteristics of the PVSE learning tasks allowed students to largely fulfil the demands of their teachers and the learning environment with the use of only surface processing strategies (van der Neut et al., 2005). That is, deep processing strategies were probably not necessary to perform the majority of the learning tasks which were part of the competence-based project. In addition, it is likely that initial surface information processing is at least in part a precondition for deeper information processing. A certain threshold level of prior knowledge creates space in the working memory of learners and thereby allows information to be processed in a more profound manner (Driscoll, 1999). Nevertheless, as expected a preference for the use of surface information processing strategies was also found to be directly but negatively associated with the quality of the students' concept maps after completion of the projects. In contrast to our expectations, no direct relations were found between a preference for deep processing strategies and the quality of the students' posttest concept maps. Once again, there may be several causes for this but the most probable cause is the specific PVSE learning context where deep processing was not strongly stimulated or elicited.

The quality of the students' concept maps at the start of the learning project also related to other variables as well. A small negative relation with a preference for deep processing strategies was found. Students who initially created rather good concept maps also seemed to prefer relatively less deep processing strategies. While this again may be explained by the aforementioned characteristics of the PVSE learning environment, which did not elicit deeper information processing, it is also possible that students were aware of their initial levels of prior knowledge as reflected in the initial concept maps and adapted their information processing strategies to their level of prior knowledge. These students may have used deeper information processing strategies *prior* to the start of the project which has obviously affected their prior knowledge in a positive manner and therefore only needed to use more superficial information processing strategies during the course of the actual project. It is questionable, however, if PVSE students are capable of such intentional deployment of information processing strategies. The foregoing explanation is highly speculative but nevertheless may merit further study, particularly in light of the significant relations between the quality of the students' concept maps at the outset of the projects and after completion of the projects. In other words, the quality of the students' initial concept maps was probably substantially influenced by their prior knowledge.

Ultimately, the promotion of the mastery and performance goal orientations appears to be a wise ambition. The highest average preference score was found on the mastery orientation scale. A performance orientation positively affected the learning results. The promotion of deep learning is nevertheless one of the starting points for competence-based education (Hmelo-Silver, 2004). This objective has yet to be realized, given the lower average scores for deep processing strategies. Although deep processing strategies have often been shown to be more effective for learning, results — including the present results — show very few learning environments to succeed at the encouragement of the use of deeper information processing strategies (Gijbels et al., 2008; Struyven et al., 2006). It is certainly possible that other types of learning tasks — in which students are stimulated to relate learning content to prior knowledge and experiences and encouraged to think critically — may effectuate the elicitation of deeper information processing. Compared to our initial expectations and the conceptual model underlying the present research, the present results also revealed some critical differences. A performance goal orientation had a positive effect upon preferences for deep processing strategies and even a direct effect upon the development of knowledge. A preference for such extrinsic learning goals appeared to be more effective than we assumed in advance.

Everything considered, the present results demonstrate the complexity of the relations between the goal orientations of students, their information processing strategies and their development of knowledge. Direct and indirect positive relations — and sometimes negative relations — between the preferred goal orientations of students and their information processing strategies (and thus their knowledge development) complicate our understanding of learning within a PVSE setting. The role of deeper information processing strategies was particularly obscure in the present study. PVSE students appeared to differ from students in other contexts in this respect. In future research, perhaps more attention should be paid to the incidence of deep learning on the part of these students, by using qualitative techniques.

Another suggestion for future research into the learning processes of PVSE students is to expand the sample size. Differences in the strengths of the relations across different types of PVSE schools can then be examined, possibly allowing multi-group analyses or multilevel structural equation modelling. Given the predominantly quantitative nature of the measurement instruments, it was not always easy to interpret the observed relations or underlying processes. It is expected that more qualitative research in the future could help in this respect.

The concept mapping method provided an accurate measurement procedure to assess the quality of the students' knowledge. The use of this procedure allowed us to clearly inspect developments in the organization and elaborateness of the students' knowledge (cf. Stoddart et al., 2000). An overall picture of the quality of the student's knowledge could be obtained via examination of the various characteristics of the concept maps. Nevertheless, the contributions of the separate indicators to the general judgements regarding the overall quality of the concept maps and the manner in which these contributions are possibly affected by particular information processing strategies should be examined in future research.

In closing, this research revealed some novel insights into student learning in competence-based PVSE. Compared to findings in other contexts, some differing results were found that can be converted to the characteristics of PVSE. As the implementation of this type of education is still in progress, the following considerations can perhaps be taken into account during the design of the learning environments. The average scale scores showed the schools to succeed in encouraging students to set a mastery goal, and this appeared to be a particularly effective orientation for stimulation of the use of both surface and deep information processing strategies. As high scores on the performance orientation scale are related to relatively well-organized and elaborate concept maps, it seems wise and feasible to promote a performance orientation as well. Because of the high scores on the mastery and performance scales, one might assume that innovations with regard to — for example — the use of authentic contexts to promote the development of knowledge, skills and attitudes may indeed lead to the desired effects upon students' goal orientations. In this respect, experimental research may be necessary to be able to give a more definite explanation about the influence of these innovations. Based upon the outcomes of the present research, however, our main advice is to prevent students from using mainly surface processing strategies and thus to stimulate students to use deeper information processing strategies to a much greater extent. Teachers can strive to accomplish this by designing tasks to have students structure learning content and the manner in which this is processed more on their own. Of course, students will still need help with the performance of tasks which are now presented in a less stepwise manner. Good guidance while students learn in an active and self-directed manner may nevertheless lead to better learning results than in current competence-based PVSE.

# CHAPTER 6[9]

## An in-depth study of competence-based learning environments in pre-vocational secondary education

**Abstract**

The purpose of this study was to obtain in-depth insight into characteristics of the learning environment and the type of guidance provided by two teachers in a "good practice" of competence-based education. The study focussed on which characteristics of the learning environment and which knowledge and behaviours of teachers regarding student guidance promoted students' learning processes and knowledge development. Data was collected per teacher through: (1) a general interview with teachers regarding their knowledge and beliefs with respect to learning environment characteristics in their classes and the type of guidance provided, (2) observations regarding the learning environment and student guidance, combined with an action-related interview based on the observations, and (3) a group interview with four students per teacher about the learning environment and type of guidance provided by the teacher. Teacher portraits showed one teacher to be an enthusiastic teacher who thinks along with students and the other teacher to be a reciprocal whole-task teacher. The teachers appeared to create a well-structured competence-based learning environment in which the provision of active support was very important.

[9] A shortened version of this chapter will be submitted for publication as: Koopman, M., Teune, P., Beijaard, D., & den Brok, P. *An in-depth study of competence-based learning environments in pre-vocational secondary education*.

## 6.1 Introduction

Recently, many Dutch Pre-Vocational Secondary Education (PVSE) schools have implemented elements of competence-based education. In this type of education, the development of competences which entail the integration of knowledge, skills and attitudes is strived for. By taking vocation-oriented competences as the starting point for learning, PVSE students are thus assumed to be sufficiently prepared for their further Vocational Education and Training (VET). Nevertheless, there are large differences between schools in the manners in which and extent to which elements of competence-based education have been implemented. Some schools have progressed quite quickly while others have implemented only a few elements of competence-based education (see Chapter 4).

The development of competence-based learning environments in PVSE can be observed from characteristics such as the integration of theory and practice and the use of authentic contexts as a basis for the formulation of learning tasks (de Bruijn et al., 2005). Competence-based PVSE schools generally strive to create learning environments in which students have to work on complex and challenging learning tasks and thereby develop problem-solving and collaborative learning skills (de Corte, 2003; Merrill, 2002; Könings, Brand-Grüwel, & van Merriënboer, 2005). In such environments, the manner in which the processes of active knowledge construction and the integration of knowledge, skills and attitudes is guided appears to be of critical importance (Kirschner, Sweller, & Clark, 2006; van Merriënboer & Paas, 2003). That is, the dimensions of the *content and organization* of the environment and the *interaction between persons* appear to be of importance (e.g., Moos 1979, Watzlawick, Beavin, & Jackson, 1967).

In the study reported here, the characteristics of powerful learning environments were operationalized using the classification of de Bruijn et al. (2005) who distinguishes between *content* and *guidance* dimensions of competence-based learning environments (see Chapter 4). The content dimension concerns the manner in which learning content is dealt with in the learning environment. De Bruijn et al. divide the content dimension into four components along which schools can differ: the actual subject matter (e.g., authenticity of the subject to be studied, integration of subject areas, tasks which resemble professional practice, learning-to-learn); the structure and range of the subject matter (i.e., the adoption of competences and authentic situations as the starting point for learning and the practice of knowledge and skills); the delivery of the subject matter (e.g., using a mixture of teaching methods, different sources of information, input from students, interaction with students); and forms of processing subject matter (e.g., active learning, exploratory learning, reflective learning) (cf. de Bruijn &

Overmaat, 2002; see also Schelfhout, Dochy, Janssens, Struyven, & Gielen, 2006; Sluijsmans, Straetmans, & van Merriënboer, 2008; Wesselink, Biemans, & Mulder, 2007). The guidance dimension concerns the different types of student guidance which teachers, experts and peers can provide (e.g., instruction, demonstration, thinking aloud, allowing autonomous student work, provision of active support, coaching, provision of help when necessary, evaluation, feedback) (cf. de Bruijn & Overmaat, 2002; see also Entwistle & Peterson, 2004; van Grinsven & Tillema, 2006; Schelfhout et al., 2006).

Little is known about how students learn in competence-based learning environments (see Chapter 5). Competence-based learning environments are expected to appeal to intrinsic student motivation and stimulate deep and meaningful learning processes (de Bruijn et al., 2005; Hmelo-Silver, 2004; Struyven, Dochy, Janssens, & Gielen, 2006). In our previous studies, insight has been gained into various aspects of student learning in different competence-based learning environments (see Chapters 4 and 5). In one of our previous quantitative studies, the goal orientations, information processing strategies and knowledge development of students were investigated. In another quantitative study, learning environments which differed in the degree to which they could be considered competence-based were compared and some unexpected results were found. The development of knowledge *negatively* related to the extent to which characteristics of competence-based education were implemented, for example. A preference for surface as opposed to deep information processing strategies was also found for many of the PVSE students in competence-based education, moreover. Nonetheless, some promising exceptions to the more general pattern were also found. Unfortunately, the results of this quantitative study did not provide insight into the potential explanations for the observed trends. A more qualitative approach is necessary to gather this type of information.

In the aforementioned quantitative study of more or less competence-based learning environments, the expected learning processes were found to occur in one particular school which had indeed implemented a number of elements of competence-based education. It was therefore decided to examine this school more in-depth as an example of "good practice" for competence-based education. Two teachers and their classes were investigated in particular in order to gain greater and more qualitative insight into just how the implementation of the elements of competence-based education worked. In other words, the cases for the present study were selected intentionally and not sampled randomly.

Working characteristics of the learning environment and the roles of the two teachers in this good practice were investigated (Meijer, Zanting, & Verloop, 2002). This included information on the type of teacher each teacher considered himself to be, each teacher's self-perceived role in the learning processes of students and each teacher's conceptions of teaching (Trigwell, Prosser, & Waterhouse, 1999; Vermunt & Verloop, 1999). Information was also gathered on the type of learning environment in the good practice, the development of this type of learning environment and the characteristics of the particular type of learning environment. The teachers were also asked about the extent to which the learning environment in the good practice corresponded with their own opinions regarding learning environments. Finally, attention was paid to stimulating and hindering factors for the realization of the competence-based learning environment within the good practice. In the present study, attention was further paid to not only the teachers' perceptions of the learning environment they created but also the opinions of students with regard to the characteristics of the learning environment and type of guidance provided. The opinions of the teachers and students were investigated via interviews and observational data were collected for purposes of comparison. The purpose of the present study was thus to gain greater insight into the qualitative characteristics of a learning environment and type of guidance which successfully elicited competence-based learning on the part of PVSE students. The central question in this study was: *Which characteristics of the learning environment and which knowledge and behaviours of teachers regarding student guidance promote students' learning processes and the development of knowledge?* This main research question was further divided into the following more specific research questions.

(a) According to teachers, what are the most important characteristics of a learning environment and student guidance aimed at the promotion of competence-based learning?
(b) How do teachers realize the most important characteristics for a competence-based learning environment and student guidance?
(c) Which stimulating and hindering factors do teachers experience with respect to competence-based education?

The results of this qualitative study will supplement the insights provided by our previous quantitative research. The present good practice example may also help schools deal with any difficulties encountered in the adaptation of their education in the direction of competence-based education. Finally, the results of this study will show how it is indeed possible to provide competence-based education in such a manner that effective PVSE learning and knowledge development are elicited.

## 6.2 Method

### 6.2.1 Selection of the cases

A good practice was selected from the results of prior quantitative studies (see Chapters 4 and 5) for more qualitative study. The good practice concerned a programme entitled Innovative Technology (IT). The IT programme was considered a good practice in light of the results of prior research in which the relations between students' goal orientations, information processing strategies and knowledge development were investigated in schools which differed in the degree to which they had implemented characteristics of competence-based education.

In the quantitative studies, some unexpected results were found. Contrary to what is strived for in competence-based education, in most of the schools studied, the students had a preference for surface as opposed to deep processing strategies. The students, moreover, appeared to develop slightly *less* knowledge in those schools which had implemented relatively more characteristics of competence-based education. With regard to the goal orientations of the students, they *did* show a preference for the pursuit of learning-oriented goals (i.e., a mastery orientation). Somewhat different results were found for the IT programme. In Table 6.1, the average scores for the students in the IT programme for preferences for goal orientations, preferences for information processing strategies and knowledge development are displayed. The results show the IT students to have goal orientation preferences which are above average on the mastery goal-orientation scale, which could range from 1 to 5. The IT students were also found to prefer deep processing strategies to a larger extent than the average student along a scale of 1 to 5. With regard to knowledge development, which was measured using pretest and posttest concept maps, the IT students showed scores above the general average on the posttest concept map and the development of knowledge measure along a scale of 1 to 5. Finally, the teachers' perceptions of the extent to which the learning environment in their school could be considered competence-based in terms of content and organization as well as guidance (i.e., the two dimensions mentioned in the Introduction of this chapter) are summarized in Table 6.1. These scores, which could range from below to above average, were compared to the total mean score for all of the schools and showed the IT programme to be largely competence-based.

**Table 6.1:** Results of prior research: characteristics of IT students compared to average student

| Variable | Scale | Average score | IT score | IT score compared to total mean score: above or below average |
|---|---|---|---|---|
| Goal orientations | Mastery | 3.60 | 3.88 | + |
| | Performance | 3.05 | 3.16 | + |
| | Work avoidance | 3.36 | 3.38 | -[a] |
| Information processing strategies | Deep proc. | 2.75 | 3.21 | + |
| | Surface proc. | 3.36 | 3.50 | + |
| Development of knowledge | Pretest | 2.77 | 2.20 | - |
| | Posttest | 3.06 | 3.20 | + |
| | Development | 3.29 | 4.13 | + |
| Categorization learning environment | Content dimension | | + | + |
| | Guidance dimension | | + | + |

[a] Negative, yet small difference which did not appear to affect the IT students' information processing strategies or knowledge development.

### 6.2.2 Participants

Two male teachers from one school participated in the study. These teachers were selected from the team of eight teachers in the programme responsible for the design of all IT learning environments and materials. The two teachers were selected on account of their experience with the IT programme and because they had the most frequent contact with students in terms of the number of hours scheduled for teaching and counselling. One of the teachers was the student counsellor for second-year students (n=14) and the other was the counsellor for third-year students (n=20). Per teacher, four students were randomly selected for an interview about the teacher.

### 6.2.3 Description of the Innovative Technology programme

The students in the IT programme were involved in the theoretical level of PVSE, which is generally considered the highest level of PVSE[10]. The IT programme includes both theory and practice. Before the start of their first year of study the students had already decided to participate in the experimental IT programme and been admitted to the programme following an intake procedure. As part of the IT programme, students are continually confronted with broad and challenging but practical assignments related to technology. These assignments are presented in a competence-based and activating manner. The programme thus has the following characteristics, among others:

- takes authentic contexts as the starting point for learning (e.g., the design of a wind turbine was the starting point for learning about alternative sources of energy);
- integrates the content of general and vocational subjects (e.g., physics, biology, geography, history, Dutch language, foreign languages and technical subjects);
- no linear building of the curriculum but, rather, adoption of a whole-task learning model in which complexity increases;
- develops the general and vocational competences of students and their careers (e.g., cooperative skills, technical skills, design skills);
- helps students build a body of knowledge around core concepts — concepts of importance in diverse situations (e.g., energy, safety, force).

In the school in question, the teachers are supposed to make systematic use of various teaching methods aimed at the development of student competences; the teaching methods may include the presentation of models, thinking out loud, coaching, scaffolding, and stimulating reflection and exploration. Meaningful student learning is supposed to be elicited by these teaching methods. For Innovative Technology, 14 core themes have been identified and are thus studied during the four years of PVSE. The themes, such as “sustainable energy” or “my future vocation,” are translated into projects which are then handled in accordance with the principles of Problem-Based Learning (PBL) (Hmelo-Silver, 2004).

[10] Dutch PVSE consists of four programmes or levels in four sectors (i.e., Care and Welfare, Technology, Business and Agriculture). The four programmes differ in the degree of difficulty and in the ratio of theoretical to practical subjects. For example, in the basic vocational and middle management vocational programmes (i.e., the most practice-oriented programmes), the students study mainly vocational subjects at a basic level of difficulty. In the combined and theoretical vocational programmes (i.e., the more theory-oriented programmes), the students study more general subjects at a higher level of difficulty.

Various theoretical problem-based learning cycles (TLC's; i.e., Theoretical Learning Cycles) and forms of skills training (PLC's; i.e., Practical Learning Cycles) are linked to each theme. The more theoretical content associated with a theme is studied in a seven-step learning cycle which proceeds according to the following steps which should be taken in order to systematically solve a problem which is largely theoretical: (1) read the problem scenario, (2) identify facts, (3) identify learning goals, hypotheses and knowledge deficiencies, (4) formulate a plan to be followed, (5) implement the plan, (6) evaluate preliminary results and (7) present final results and take it to a higher level of abstraction. The more practical learning content associated with a theme is studied in a four-step learning cycle in which the students are supposed to: (1) prepare and familiarize themselves with the task, (2) train the relevant skill in a strongly guided situation, (3) practice the skill more independently, and (4) receive feedback.

In the present study, one core theme (i.e., project) was investigated per teacher. The project for the teacher of second-year students was "sustainable energy" and aimed at the development of a wide range of knowledge, skills and attitudes which pertain to wind and wind turbines. The project for the teacher of third-year students was "my future vocation" and aimed at the development of a professional identity and the professional competences required for future work.

### 6.2.4 Data collection

In order to gain a detailed picture of the learning environments for both teachers, data was collected in the following manners per teacher:

(1) A general interview was conducted with regard to the teacher's knowledge and beliefs about the characteristics of the learning environment in his classes and the type of guidance that he provides for students;
(2) Observations were undertaken to determine the actual characteristics of the learning environment and the nature of the student-teacher interactions in terms of type of student guidance, followed by an action-related interview to clarify and/or supplement information provided by the observations;
(3) A group interview with four IT students per teacher was conducted to gain insight into their opinions about the characteristics of the learning environment and type of guidance provided by the teacher.

In line with Goodwin (2005), in this manner a "portrait" could be made of the teachers' learning environments based on different sources of information.

The semi-structured general interview consisted of questions aimed at obtaining a general impression of the teacher's conceptions of teaching and learning.

Information was gathered on:

- the teacher's background (e.g., amount of teaching experience, teaching tasks and how the teacher got involved in the IT programme);
- the type of teacher the teacher considered himself to be (i.e., the self-perceived role of the teacher in the learning processes of students and the teacher's conception about teaching);
- the IT programme (i.e., its development, its characteristics and the degree to which the project corresponded with the teacher's opinions regarding education);
- factors perceived to stimulate/hinder the realization of the particular IT programme.

The interviews were audio-taped and transcribed for subsequent analysis.

Per teacher, a more theoretical lesson and a more practical lesson was selected for observation. This was done in consultation with the teachers themselves, and the observations were distributed across the project weeks. The observations and subsequent interviews were aimed at mapping the actual behaviour of the teachers and their explanations for their own behaviour. An observational coding scheme for the characteristics of competence-based learning environments and student-teacher interactions concerning student guidance as developed by de Bruijn et al. (2005) was used (see Appendix B). The coding scheme had two groups of coding categories: one group concerned the characteristics of the learning environment (i.e., 15 characteristics) and one group concerned the type of guidance provided by the teacher (i.e., 9 types of guidance). For each of the 24 coding categories, a description (i.e., operationalization of the relevant characteristic or type of guidance) was available (cf. de Bruijn et al., 2005). The following were among the characteristics of the learning environment, for example:

- an emphasis on functional and authentic learning;
- a curriculum arranged around situations and actions occurring in professional practice;
- explicit attention to the development of learning skills and problem solving skills;
- zooming in on partial skills and knowledge in complex working situations.

The nine types of teacher guidance distinguished were: instruction, demonstration, thinking aloud, allowing autonomous student work, provision of active support, coaching, provision of help when necessary, evaluation and feedback (see the second part of Appendix B for further description of these variables). During the observations, field notes were also made on events which pertained to the content of the observation scheme. After the completion of an observation, an observation scheme was immediately completed to prepare the interviewer for the action-related interview which was based upon the results of the observation. The action-related interviews were conducted on the same day as the observations as this presumably allowed the teachers to remember what they did during the lesson. For each characteristic of the learning environment and type of teacher guidance, a summary was created. During their observation, the teachers were also video-recorded.

In the action-related interviews which were conducted shortly after the observations, various topics were addressed. Context-specific information about the characteristics of the learning environment and student guidance was gathered. First, the teachers were asked to judge and elaborate upon the extent to which the learning environment which was just observed was typical of the IT programme. After that, the observed characteristics of the learning environment and student guidance provided by the teacher were discussed extensively. For this, the teachers were presented with the summary of the findings per learning environment characteristic and type of guidance. Finally, the teachers were asked about each of the following for the characteristics of the observed learning environment and types of guidance: (a) did they agree with the summary, (b) why did they do things in the manner observed and — when relevant — (c) why did they do things differently in the observed environment than mentioned in the general interview. These interviews were also audio-taped and transcribed for further analysis.

The group interviews with the four students per teacher assessed the opinions of the students with regard to the characteristics of the learning environment and the manner in which they were guided by their teacher. The students were asked, for example, if they thought that the learning content was useful for their future careers and about what the teacher did to make them learn more effectively. In order to attain the most complete picture possible of the IT learning environment and student guidance, students' perceptions were integrated with their teacher's conceptions of teaching and learning, observations of actual teacher behaviour and teacher explanations of their own behaviour. Once again, the student interviews were audio-taped and transcribed for analysis.

The "sustainable energy" and "my future vocation" projects each lasted a total of 10 weeks. As depicted in Table 6.2, data collection was spread across this period.

**Table 6.2:** Time course for the collection of data per teacher

| Instrument | Time course | Duration |
|---|---|---|
| General interview | Prior to project initiation | 1.5 hours |
| Observation + action-related interview 1 | Weeks 2 – 5 of the project | Observation: 100 minutes; interview 45 minutes |
| Observation + action-related interview 2 | Weeks 6 - 9 of the project | Observation: 100 minutes; interview 45 minutes |
| Interview with 4 students | Week 9 or 10 of the project | 30 minutes |

### 6.2.5 Data analysis

All of the teacher interviews were coded using ATLAS.ti, which is a software application for the qualitative analysis of textual data. The coding of the interviews was conducted in three phases. In the first phase, *labels were ascribed to the statements* of the teachers. This was done in two manners. Statements regarding the characteristics of the learning environment and the types of guidance provided were coded using the categories from the observational coding scheme (see Appendix B). A grounded theory approach was also adopted to openly code statements regarding other topics in an iterative manner (Glaser & Strauss, 1999). The sensitizing concepts used for this open coding concerned the type of teacher and teacher conceptions of teaching and learning, the starting points for the IT programme and characteristics of it, roles and tasks in the development of the relevant IT project, stimulating and hindering factors, professionalization and teacher learning. In the second phase, *axial coding was applied to improve the coding structure*. This entailed the combination and/or elimination of codes when redundant and the *initial grouping of the codes* according to the following overarching themes: the teacher's background characteristics, teacher tasks, typification of the teacher, starting points for the learning environment, characteristics of the learning environment, type of student guidance, student competences, characteristics of PVSE students, development of the project (including strengths and possible weaknesses) and the presence of characteristics of professional learning communities. Sample statements from the teacher interviews were linked to each code in order to illustrate the relevant content. In the third phase, another researcher was asked to *decide if the overarching themes, codes themselves and sample statements were clearly and accurately described*.

The video-recorded observations of the teachers were coded using the observation scheme (see Appendix B). The tapes were stopped every 3 to 5 minutes.

The observation scheme was then used to summarize the events and assign the relevant codes for that observation fragment. Per fragment, all relevant codes from the observation scheme could be used. For each of the codes, a summary of the relevant learning environment characteristic and type of student guidance provided by the teacher was made.

The group interviews with the four students per teacher were coded using the themes and codes identified for the general teacher interviews. The findings for each interview were then summarized per overarching theme.

An in-depth teacher portrait was thus established on the basis of the general interviews, teacher observations, action-related interviews, and student interviews. The aforementioned findings were summarized under the following headings: background; conceptions of teaching and learning; observed behaviour and teacher explanations for this behaviour subdivided into important starting points, student learning and type of guidance provided; and findings based upon the group interview with four students. To determine the reliability and validity of the data collected, the teacher portraits were presented to the two teachers for a member check (Glaser, 2004). The teachers were asked to provide remarks and any additional information which they thought necessary. An audit procedure was then conducted by another researcher to check the visibility, comprehensibility and acceptability of the analyses (Akkerman, Admiraal, Brekelmans, & Oost, 2006; Guba, 1981). The auditor was given a process document in which the entire procedure for the gathering of the data and the analyses of the data was documented. All of the raw data, transcribed data, data coded using ATLAS.ti, the observational coding scheme, the summaries of the results per instrument, the in-depth teacher portraits and a draft version of the present chapter were also placed at the disposal of the auditor who then assessed the links between the conclusions and the data for justifiability and accuracy. The manner in which the data was gathered was judged to be accurate and acceptable. The validity of the results is further demonstrated by supplying representative quotes from the participants in the Results section of this chapter (Maso & Smaling, 1998).

## 6.3 Results

In the following, the in-depth teacher portraits will be presented. In Table 6.3, an overview of the teacher portraits and thus the similarities and differences between the two teachers can be found.[11]

[11] The names of these teachers are fictional

**Table 6.3:** Overview of the findings per teacher

| Topic | Harry | Jan |
|---|---|---|
| Conceptions of teaching and learning | Structured problem-based learning | Cooperative problem-based learning |
| | Connecting to how students prefer to learn: allow to work autonomously, active learning, practical tasks | Connecting to how students prefer to learn: use of motivating and up-to-date tasks, limited amount of whole-class instruction |
| | Emphasise student strengths | Compassion; guidance of individual student |
| | Attention to learning-to-learn | Attention to learning to cooperate |
| | Driven by students' questions | Driven by students' questions |
| Starting points for the education provided | Competence-based education consisting of themes and associated theoretical and practical learning cycles (authentic learning tasks) | Competence-based education consisting of themes and associated theoretical and practical learning cycles (authentic learning tasks) |
| | Student-centred and career-oriented | Integration and whole-task learning |
| | Use of and highlighting of aids such as a design cycle for structure | Just-in-time presentation of relevant theory or skills training |
| | Rich and structured learning environment | Rich and structured learning environment |
| | Assessment of competences; verification using core goals | Assessment of competences; using portfolio |
| | Portfolio: only process reports | Portfolio: complete digital document |
| Student learning | Active learning, experimentation | Active learning with active support |
| | Increased autonomy | Interaction between students: input from fellow students is crucial |
| Types of guidance | Active support and coaching to help the learning process smoothly evolve (anticipation of problems) | Active support (guidance of students in anticipated direction); attention to the clarification of concepts and principles |
| | Enthusiastic assistance of students in the creation of their designs | Reciprocal teaching: asking counter-questions as opposed to the supply of answers |
| Student perceptions | Appreciation of teaching methods and usefulness of the project content | Appreciation of teaching methods and student-centeredness |

### 6.3.1 Harry, the enthusiastic teacher who thinks along with students

*Background*

Harry is 51 years old and has only been working in education for four years. At present, he is still doing his Technology teacher training which he will finish in the near future and allows him to teach the first years of secondary school. His previous education included pre-university education and a senior secondary technical study (i.e., electrical engineering). Before he transferred into education, Harry worked as a mechanic for a number of years and later as a "sustainable energy" project manager. Harry has been involved in the IT programme since the first year of its implementation some three years prior to the conduct of the present study. All of his tasks as a teacher have been related to Innovative Technology. His curriculum development tasks have concerned the compilation, evaluation and adjustment of various practice-oriented elements of education for use in the IT programme (i.e., the writing and adjustment of various learning cycles). He has carried out these developmental tasks in cooperation with colleagues and asked students to provide feedback. Harry has encountered a problem, namely the small amount of time officially allocated for purposes of curriculum development, and therefore invested much of his own time. His tasks have also involved the counselling of third-year IT students. Harry was allowed to decide for himself whether he wanted to participate in the programme IT or not.

> *It suited me to a T and it still does. I really am a researcher and a technician, and I like to develop things, to draw things and to physically make things. This is right up my alley.*

Harry was not involved in the planning phase of the IT programme due to his teacher-training course load. Despite this, Harry agrees almost completely with the starting points for the programme. The programme is also clearly connected to his interests and capacities, which means that Harry is highly motivated to participate in the programme.

*Conceptions of teaching and learning*

Harry typifies himself as a teacher with a preference for structure (G1, G4, G6; see Appendix B for descriptions of these codes).

> *At the beginning of the lesson, I want to present something clearly in a small amount of time. I'm not a "teaching" person. I present rough ideas or I only write a plan on the blackboard. I tell the students the aim of the lesson and that should take no more than 10 to 15 minutes. Then they have to get down to it, and I guide them by walking around and coaching when necessary.*

According to Harry, this manner of working best matches the manner in which most PVSE students prefer to learn: by working autonomously and active engagement in practical learning tasks (C10). Harry sees himself as interested in students. He reacts flexibly when unexpected events occur. He views himself as a coach of the student's individual learning process with the task of adjusting and regulating this process as needed (G6). His starting points for teaching are to emphasize the strengths of the students and instill self-confidence. From such a perspective, he tries to connect to the student's existing level of competence and let them practice taking that level as a point of departure for learning.

> *You have to get to know your students. Preferably, you have to accompany them throughout their whole trajectory so you get to know them from the first until the last year. Then you can focus rather quickly on what they are already good at.*

Harry also reports paying attention to the development of learning skills, particularly in his counselling and advising of students. Students who find it difficult to select information, for example, are counselled in these lessons (C3). And despite the fact that the level of the IT students is relatively high, Harry observes that it is difficult to elicit deep student learning. Nevertheless, he tries to encourage such learning by drawing attention to relations and by making concepts and principles as concrete as possible and linking them to the students' interests. According to Harry, an environment which elicits optimal student learning should be spacious, encompass different types of work places (C6) and involve authentic practice-oriented tasks (C1). Challenging and interesting problem-based learning is an ideal to be aimed for, according to Harry.

> *In order to make it meaningful for them [the students] and also because school work has to be of current interest. It should not be old learning content. It should not be purely meant to learn one specific skill. It has to be put in a larger context, so that they can see clearly that mathematics is useful when they have to build a fairground attraction. That it is useful to work conscientiously, because otherwise it does not fit and it doesn't work out as well as intended. So, it mainly comes down to integration and the drawing of connections.*

Via problem-based learning, students develop competences in which knowledge but also technical skills play an important role (C5). Education should be aimed at the careers of students, according to Harry, who sees himself as playing an active role in this via conversations as a teacher with the students. Preferably, there should be room for independent student work (C11) and cooperative learning (C7) in such a learning environment, and the teacher should provide feedback on the learning process (G9).

> *This is the core: An individual approach to the students… [Students] learning how to cooperate well, knowing how to benefit from each other's strengths…yes, and creating a nice atmosphere.*

Harry prefers to start from the questions of the students themselves and sees active support of students to answer these questions (G5) as a major task for himself. In the opinion of Harry, it is important that education connects to the interests of students and their perceptions of the environment. The topics to be dealt with in an optimal learning environment are — according to Harry — broad, varied and related to technology and design. The learning environments preferred by Harry combine quite well with the starting points for the IT programme and projects. Harry also thinks that it is important to keep in touch with the parents of students and keep each other informed about the students' ups and downs.

*Observed teacher behaviour and own explanations for it*

<u>*Important starting points*</u>

In the lessons of Harry, the emphasis was on mainly *functional and authentic learning* (C1). He had students work on tasks which could occur in actual practice (i.e., the work which students were being educated for). In both of the observed lessons, the students had to draw a design which they later had to make. They did this following the realistic steps of brainstorming, sketching, technical drawing and finally production. Via this sequence, more or less connected bits of learning content arose. According to Harry, his manner of connecting learning content proceeds as follows.

> *By making themes of roughly ten weeks and by touching on topics which are related to each other. Like in this period, "my future vocation." Then we pay attention to tax returns, the founding of a company, pay slips: How does that work and how do you search for your job…*

An example of how Harry prevents fragmentation in education was the subtask which allowed students to experiment with parts of a diode (i.e., an electronic device that allows current to flow in one direction only). This task was not separated from the design task because the students needed the knowledge developed via experimentation with the subtask for the making of a good design. The designs of the students had to be feasible, operational and meet the demands of customers. During the lessons, Harry did not work with real companies as task masters. In the interview Harry stated:

> *We started with ten companies four years ago. We had two meetings. And – the word is in fashion – there was no connection. There was no…we couldn't find each other at that time. We get this criticism more often. And it is just critique: we will have to bond with the business world.*

The curriculum Harry used was *arranged around situations and actions occurring in professional practice* (C2). Harry also aimed to integrate theory and practice. Certain knowledge and skills were related to practice-oriented tasks and, in such a manner, knowledge and skills were always presented within the context of actual practice. In other words, Harry *zoomed from complex working situations to underlying (partial) skills and knowledge* (C4). Harry also employed a whole-task learning model in his teaching.

> *[We are] dealing with all possible topics and themes in the whole PVSE education spread across 14 periods. Maybe our themes are not chosen well and we will have to adjust them at some point, but we think we can cover all aspects students can come across in their*

*future jobs with this choice.*

In the observed lessons, the design task appeared to serve as an umbrella and subsume, for example, the knowledge necessary to let everything function well and the associated skills needed to make and assemble a design (e.g., sketching and welding). Education and assessment are *competence-based* in the opinion of Harry (C5). For example, in the observed lessons, the students worked on such competences as cooperation, technical skills, creativity, planning, organizing and performance. The extent to which there was coverage of these competences throughout the entire educational programme or in the descriptions of the competences was not directly visible from the observed lessons. According to Harry, however, the following was the case.

*We have an Excel table for this purpose, and we started to keep it up to date somewhere in the second year of the project. In the beginning, we worked off-the-cuff. Then we started to mark which core goals [formulated for PVSE by the government] we achieved and at this moment we are determining which core goals are marked unsatisfactory. We will try to address these in a TLC [i.e., a theoretical learning cycle]. In such a manner, we constantly have to navigate when we discover that they aren't competent enough in a certain area and adapt TLC's and PLC's [i.e., the theoretical and practical learning cycles] to that.*

During the observed lessons, Harry regularly paid attention to the development of learning skills and problem solving (C3). He did this, for example, by continually reverting to the working procedure, by pointing out the use of the design cycle to students and by repeating the steps to be taken during a design cycle. He also assisted the students in thinking up solutions for problems and helped them plan their activities. Via the anticipation of problems, Harry also tries to do the following.

*Teach them how to play chess. So that they learn to think about the choices they make. That they learn how to think a few steps ahead and oversee the consequences of making a particular choice.*

The students used *different sources of information, teaching aids and places to work* within the school (C6). Nevertheless, one source of information was very strongly represented: the use of the internet via the laptops of the students. Student use of the internet is, in fact, the most important source of knowledge.

*Yes, the only source or the main source is indeed the internet. Books are used too and multimedia, but that is actually the internet as well…Yes, the book is out of style…In fact, we only use the prior knowledge they have and all sources we can find on the internet. I do try to guide them. When they get stranded, I often give them 3, 4 keywords and I point to Wikipedia, the ICQ website. At a certain moment they will have to compile their own list with sources of information and document the sites they often end up on.*

Different tools and materials are also used to make the designs, and the students are allowed to choose the tools and materials themselves. Work places were available in the classroom for all steps in the TLC's. A *mix of teaching methods* was part of the problem-based learning implemented by Harry (C9). The lessons started with a form of whole-class instruction, which was followed by student brainstorming and designing in pairs and then a form of whole-class feedback and evaluation. A *fixed programme order* could thus be recognized (C14). The TLC's were structured according to a seven-step learning cycle and the PLC's were structured according to a four-step learning cycle and a design cycle. The *systematic construction of skills* occupied an important position in the lessons of Harry (C15). PLC's were regularly undertaken. These were the tools for larger, more complex projects to be acquired and practiced. Harry used student *portfolios* (C13) although the development of this element within the IT programme was still in the early stages. During the lessons, Harry pointed out that the students had to report on the whole design and production process and, as part of this, justify the choices made. He elaborated on the report requirements. Afterwards, he also related the following.

> *They wrote a short report on it. The drawing has to be included. In general, they make a picture of the piece of work which is saved electronically. That started at the beginning of this period. They were given a folder which covers the first through fourth years. In this folder, they can keep everything up to date. [The criteria] are still…a point which needs attention. I indicate that the report is 50% of the mark and that the appearance of the product they designed is — of course — 50% as well. The technology is dealt with in two parts: Does it function and are good solutions thought of? The design is assessed. Finishing and originality. And finally, the completeness of the report. This is not indicated very specifically, like when it contains this, this and that, you will receive a mark of 10.*

*Student learning*

During the observed lessons, *interaction* between the students was seen to be quite frequent (C7). After short instruction provided by Harry, the students cooperated and consulted each other. For example, they had to design something together or help each other with their individual designs. As a result, the students indeed *had to depend upon each other for the conduct of tasks* (C8). Harry had the students cooperate in order for them to benefit from each other's knowledge and ideas. Also, in the phase of answering the questions students had themselves, the input of fellow students was crucial: pairs of students had to answer particular questions and share their answers with the others. Afterwards, Harry noted the following.

> *The reason [to chose for] cooperative learning is the fact that they are on the same level regarding communication. They can explain things better to each other than I can. And they can use each other's strengths. Give ideas to each other. When they are brainstorming, a kind of "flow" is created in which they formulate ideas in an unrestrained manner…and yes, dare to make mistakes amongst each other.*

An important characteristic of Harry's teaching is that *students learn in an active* *and exploratory manner* in almost all lessons (C10). Harry saw that the students constantly occupied themselves. He deliberately let them experiment with the diode. In addition, he constantly made sure that the students had certain questions to think about, such as the feasibility of the design or the position of the technology in the design. Based on his remarks, the students had to think — on their own — about required adjustments to the designs. After the lessons, Harry described the knowledge and skills which should develop as a result of his teaching methods and the task at hand.

> *Two reasons: drawing skills and technical skills very commonly exist. Sketching is something they have to become a natural at. A number of them are already very competent in this respect but some of them will have to keep practicing. Thinking three-dimensional and problem-solving thinking are things we want them to become familiar with.*

Harry often *stimulated the students to think of solutions by themselves* (C11). He certainly did not let the students "swim". Even though the students were expected to increasingly think up solutions on their own, he was very active in the search for explanations as well. He often mentioned potential bottlenecks and problems and thus encouraged the students contemplate possible solutions to these. He also saw that the students could justify and explain their inventions (i.e., think their ideas through again). With regard to this, Harry mentioned the following.

> *Yes, I think along with and assist the students. I suggest what is — in my opinion — a better direction. I don't tell them everything about it. I only provide a direction which they must then pursue themselves.*

Possibly related to this is an emphasis on *reflective learning* (C12). The influence of Harry along these lines was large as well: he clearly took the initiative and stimulated reflection. Harry often tried to make the students as conscious as possible of potential difficulties with their designs and encouraged them to reflect upon possible (i.e., alternative) solutions. In addition to this, Harry posed questions to stimulate his students to think about a certain concept (e.g., *"Is this innovative?"*) or the utility of a particular design idea.

<u>*Types of guidance*</u>

In the two lessons observed for Harry, all nine types of guidance — as described by de Bruijn et al. (2005) — were apparent to a lesser or greater degree. Harry initiated the lessons with short whole-class *instruction* (G1). After that, instruction occurred in mainly one-on-one situations; for example, when he repeated the procedure for a task or explained certain concepts. Harry, himself, describes this in the following manner.

> *Yes, that [way of working] can be very well connected to this type of education. It can be connected to differences in the level of students as well. In my opinion, when you stand in front of the class too long, you only captivate maybe 5 out of the 20 students and the rest turn their backs. It works very well to give them individual attention.*

*Demonstration* (G2) or showing students how to do something was rarely visible in Harry' lessons. Demonstration was limited to showing students how to sketch. Another form of guidance deployed to only a very limited extent was *thinking aloud* (G3). The situations in which Harry was observed to think aloud concerned mainly the regulation of the learning process: to show how to make the thinking processes related to a possible approach, planning or next steps in the learning process. Thinking aloud for purposes of providing insight into the thinking of experts occurred to a lesser degree. When Harry did this, it usually involved the provision of assistance or thinking along with the student. Harry would mention, for example, a number of possibilities for the students to choose from. The reason that Harry thought aloud so little was as follows.

> *When it does not come naturally, I do [think aloud]. But not when […]. When things go naturally, I try to release things as much as possible because then you can get unexpected turns. End up with things you otherwise would never have met. Actually, in principle, I prefer to let them work completely autonomously. It can be inhibiting when you put too much of your own stamp on the lesson when they get the idea that "Mr. [Smith] will provide an idea sometime soon and then we can go on automatically from there".*

During the largest part of the observed lessons, Harry *allowed autonomous student work* (G4). He leaves the manner of task conduct up to the students. An important accompanying teacher task, then, is to *provide active support* (G5). He walked around and questioned students about their activities. He often provided suggestions, mentioned alternative possibilities and pointed out extra steps to be considered. In addition to this, he checked the students' progress.

> *To keep the process going. Minding that they don't linger on small bumps in the road. And, yes, maybe that's a pitfall because I like it so much myself. […] That's something I often fall for: Talking with students when there's a good idea.*

Harry often initiated the provision of support in the first lesson himself (i.e., the more theoretical lesson). In the second lesson, however, he more frequently *provided help when necessary* (G7). In the second — more practical — lesson, the students indeed came to Harry more often with questions about, for example, the task demands. The students also asked for comments on their ideas. The degree to which Harry provided active support or help when asked to do so depended in part upon the stage at which the student was in the conduct of the task.

> *The task was specific. In the previous lesson, the task was more open and now it was more enclosed in a frame. Like it occurs in practice: make a lamp. And not like: think of something mechatronical…that's more difficult, for some.*

In sum, it can be concluded that when providing guidance, Harry focused on mainly *coaching* of the learning process (G6). He gave students tips on how to approach the task, posed questions about the way in which the students were going to conduct the task, provided extra information about tasks and accompanying demands and pointed out sources of information to be used for the conduct of tasks. Harry did all this to keep the learning process going. Harry also paid attention to the quality of the students' learning and the ongoing learning process or, in other words, *evaluation* (G8) and *feedback* (G9). Feedback was mainly provided in combination with coaching suggestions, requested help or active support. Harry also encouraged students. At the end of a lesson, for example, Harry might summarize all suggestions, provide his opinion about how the students had worked and offer suggestions for the next lesson. Harry also sometimes evaluated the learning result and, during a lesson, he sometimes provided a value judgement with regard to an idea or design.

*Findings based upon the interview with four students*

In the observed project "my future vocation", the students recognized the starting point that education is supposed to be career-oriented. For a number of the students, the goal of the project was also attained.

> *First, I wanted to become an architect but, through this [project], I know more about what this means and I don't like it as much anymore. And when searching for schools and what you can do out there, I did find what I want to do. I want to become a graphic designer.*

The students were also quite enthusiastic about what they did and learned in the project. The broad and practical character of the project, in particular, and the degree of freedom and autonomy given to the students was greatly appreciated. Moreover, from the students' descriptions of the activities which they undertook within the framework of the project it can be concluded that they were active the majority of the time. For example, they tested things, made reports, used the internet as an important source of information and visited a market at which schools presented themselves. The students recognized certain knowledge that was dealt with in the observed PLC's.

> *In principle, it contains mathematics. And science too. Not related to how you must draw this or that but it was related to how an angle is supposed to be…90 degrees or so, that already can be considered mathematics. And measuring and all.*

The students recognized the use of the knowledge, skills and attitudes which they were developing during the project, and they were able to think up practical examples in which their acquired knowledge could be used again. With respect to the teacher's guidance, the students reported receiving enough help and help which was good when requested and that the help connected to their demands (G7).

> *Student 1: Yes, sometimes [when you are being helped] you have to think of something else but it is always in the same direction as your primary idea. But then it has to be made differently according to the teacher. Then he says that you can better do it this or that way, because that will work more easily.*
>
> *Student 2: Yes, actually he just helps well when you really have a question, not when you don't have a question. He does walk around then and looks at what you do and when he*

> *sees it won't work out, he says something about it.*

The students reported the receipt of clear and relevant answers and feedback which helped them make progress. The students were a little dissatisfied with the ratio of practical PLC's compared to theoretical TLC's in the third year. They would rather work just as much with their hands as in the previous years of PVSE.

### 6.3.2 Jan, the reciprocal whole-task teacher

*Background*

Jan is 31 years old and has been working for five years in PVSE. He obtained a grade two teaching qualification at the Pedagogical Technological University of Applied Sciences, a programme that prepares for teaching technical subjects and practical training in PVSE and vocational education and training. His previous education included senior general secondary education and senior secondary technical education (i.e., car mechanics). Prior to his involvement in the IT programme, he taught car mechanics for two years at the same school. Jan has been involved in the development of the IT programme since a few months after its initial development; the first year as a curriculum developer and later as a curriculum developer and teacher. Jan chose to participate in the IT programme because he liked the idea of starting something new and the broad spectrum of technology has been central in the IT programme. From the moment that the IT programme was implemented three years ago, Jan's tasks have all revolved around IT, including second-year student counselling. His curriculum development tasks have involved the writing and adaptation of TLC's (i.e., theoretical learning cycles) and skills training. He usually starts with the design of these alone, later asks his colleagues for feedback and then adjusts things accordingly. He greatly benefits from the input of colleagues.

> *The interdisciplinary IT teaching team consists of four completely different individuals. These four people complement each other perfectly. For example, I am competent in handling computers, cars, technique and other stuff. There is somebody who's very capable at electronics, student counselling and so forth. One person has a lot of experience in the guiding and coaching of students; for example, [handling] conflicts and recognizing certain impairments. So, actually our team…yes, it's not a perfect team, but many competences and skills are actually in our team.*

Thus, Jan and his colleagues have regularly supported each other. A problem, however, is the limited amount of time made available to them for development activities. A related problem, also mentioned by Harry, is the fact that teachers who did not volunteer to participate in the IT programme are now involved (i.e., involved since the current school year).

*Conceptions of teaching and learning*

Jan describes himself as a compassionate and helpful teacher. He is strongly involved with students and sometimes even helps them with their leisure time activities. His focus is on mainly the guidance of individual students in order to help them develop in their own manner and at their own pace. He has solely given direction to this development (G6).

> *The process is very important: The guidance of students. So, also trying to enhance their self-esteem when they are feeling down. You see, when you look at a product, you can always determine if someone is good or not, but I don't think that's very important. The student starts at a certain level and that level has to improve.*

Jan values getting students motivated and tries to effectuate this by challenging and exciting students at the beginning of a lesson. This may be done by showing interesting films, addressing up-to-date issues and connecting to student perceptions of the environment. To be in tune with the characteristics of PVSE students, Jan tries to limit the amount of whole-class instruction (G1). With respect to student motivation, Jan wants students to apply their own creativity and therefore always has them make their own designs. At the stage of the TLC's in which the students have to collect information, he also has the students do this on the basis of their own questions. Jan wants his students to learn how to work autonomously and take responsibility (C11, G4). According to Jan, PVSE students are very capable of these things when a sufficient framework is provided and the students are approached positively. Learning how to cooperate is also an important demand which Jan places on his students (C7). He similarly tries to see that students benefit from each other's input (C8).

> *Because students, I have noticed, more quickly accept things from another student than from a teacher. Not in every case, of course, but they often do. Then [the other student] learns how to stand out, how to present himself. You really kill two birds with one stone then.*

In Jan's teaching, broad competences are central and include such matters as creativity, design, presentation skills and technical skills. Initially, students were evaluated with regard to such competences using a list of concretely observable indicators to be assessed by (preferably) multiple judges. An important starting point for doing this was the use of a whole-task learning model (C4).

> *Normally you supply small pieces of information and then the student thinks: "Right, why do I need this, why do I have to learn this?" When you do it the other way around, the student sees why he has to learn it. So he has to solve a problem, but he can't because he doesn't have all tools yet. When a student wants to come up with a solution, he has to familiarize himself with the tools. When you get the student excited enough, he will really want to acquire the tools. He can find them [the tools] in the environment; he can find them with me or fellow students or via the internet, via computer programs. I have already thought of the tools in advance […]: in a digital TLC, you always have the button "sources"*

*which is where I put the most important websites or video fragments and Flash animations for them to work with.*

Another — related — starting point is the integration of subjects. By letting elements of all kinds of general subjects come up in the projects, students can learn via experimentation about them and what they learn becomes more meaningful than when the subjects and elements are presented separately. If he was not constrained by time, Jan would also consider excursions to be an important part of the curriculum — mainly for exposure to what a good attitude towards work is and to orient students towards their future careers.

*That they see how it will be in the end. We teach students something here and they often say: "That's not true." When they really go to a company and they see how it really works there, they are confronted with the facts. For example, uniformity, that everyone should behave. Seeing that everyone is working quietly. And, at the same time, considering whether this suits them. For example, in an architect's office: an architect does all these things…do I like that, because I thought it was all drawing but all sorts of other things are connected to this as well.*

*Observed teacher behaviour and own explanations for it*

<u>*Important starting points*</u>

During Jan's lessons, tasks which can actually occur in actual practice stood central and the separate parts of these tasks were connected to the central theme of the IT projects. Jan thus had his students *perform functional and authentic tasks* (C1). In a TLC, the students had to search for information on wind as a force. The acquired knowledge could then be used in the development of their own wind turbines during the PLC. In such a manner, Jan avoided fragmentation.

*We don't want to deliver geography, history, biology or science — for example — separately, but we just want to create a context-containing learning environment. […] It also has to do with why they have to learn something. I used to think in school "Why do I have to learn this? I'm not going to do it, I don't need it." Things sink in quicker when you create a rich and authentic learning environment. Take riding a bicycle. When you have learned how to ride a bicycle, it's a piece of cake. But you first have to practice. And when things have sunk in, you can basically ride with your eyes closed and your hands in the air, so to say.*

All in all, the *curriculum was arranged around situations and actions occurring in professional practice* (C2). During the IT project, situations and actions related to the theme stood central. Certain knowledge and skills were related to this, which were accommodated to TLC's and PLC's. The IT project and its theme provided an umbrella for specific knowledge, skills and content to be subsumed under. Jan also deliberately *zoomed in from complex working situations to underlying (partial) skills and knowledge* (C4).

*You can present everything separately, for example how electronics work, how to work*

> *with wood, how to make a construction. But then they don't see the big picture. Then they don't know why they must do something. And now you can explain that everything will collapse when a construction is not strong enough and when they put something on top of it. You can immediately nail down the problem. For example: "The construction is not good enough, so you will have to go back and make it more solid." Then you can tell them: "You have to put in crosswise pipes, which is more solid." You can then integrate pieces of theory about technique and [...] they will listen because they just want to fix their design. [I] try to keep it close to the moment at which they actually need it.*

During his lessons, Jan regularly paid attention to the *development of learning skills and problem solving* (C3). For example, he frequently considered how a task can best be approached together with his students or provided tips to help the students get on track. During the TLC, he also posed lots of questions in order to better define the students' learning questions. During the PLC, Jan often pointed out certain problems with the making of the product in advance and thereby helped the students take the problems immediately into consideration. In addition, Jan paid extensive attention to the development of the student's capacity to collect information. Jan's teaching was aimed at the development of *competences* (C5). These competences were also the most important starting point for his assessment of the students. The decision to work with competences and one such as "cooperation" is explained in the following manner by Jan.

> *They are being educated for middle-management level professions, and there they will have to learn how to manage and delegate. The earlier you start, the better it is. And now it is not like: "You are the boss, you are in charge," but they just have to learn how to cooperate and allocate tasks. Accept each other, deal with setbacks and so on.*

In the observed lessons, the students mainly worked on the competences of "cooperation," "technical skills," "creativity," "mathematics and exact sciences," "language skills" and "presentation skills." The development of the competences was assessed at the end of the project when the teacher and students estimated the achieved level of individual competence, conferred on this and made agreements about what to work on in the next project. Students kept track of their development in a digital *portfolio* (C13). Set elements for the portfolio were a log, photographs and video fragments of the intermediate and final products, PowerPoint presentations and a personal development plan which includes agreements made with regard to what to work on (i.e., what competences to develop). The portfolio was taken into account during the assessment of the students' competences. Jan's teaching was also rich in that *many different sources of information, teaching aids and places of work* were used (C6). During the TLC, the internet was the most important source of information; during the PLC, information came mainly from Jan himself. In the PLC, students were allowed to use various resources, tools and materials. There were different places to work within the large classroom which was suitable for whole-class introduction of a task, working in pairs and the deployment of different techniques for the construction of a wind turbine. *Different teaching methods* were also used within the different learning cycles (C9). During the observed lessons, brief whole-class instruction was followed by mainly student cooperation. And while cooperating on a learning cycle, the students had to brainstorm, collect information, order this information, interpret the information, understand the relevant concepts and principles and, finally, make a presentation. Jan stated the following with regard to the variety of teaching methods used.

> *Sometimes I do it a little more briefly: brainstorming, sketching and construction. It depends on the task. It's a little different when you have to construct something than when you have to look something up. […] For example, sometimes they have to make a PowerPoint presentation or a Moviemaker video. Sometimes they have to make a prototype so they can explain something to the rest of the class using the prototype. So you have to vary, otherwise it becomes boring.*

The fact that the IT programme is built around theoretical and practical learning cycles implies a *fixed programme order* (C14). The TLC's were structured as a seven-step learning cycle and the PLC's were structured as a four-step learning cycle. The systematic construction of skills was thus involved. Moreover, in the PLC students applied skills developed in other lessons. Together with the students, Jan made sure that the students improved these skills. The knowledge which students developed in the TLC provided the "theoretical tools" to be used to improve the design and construction of wind turbines. And along these lines, Jan noted the following.

> *Soon they will have to work with electricity. They will have to undertake the so-called "circuit" practical learning cycle then. They will practice with how things like that work. They can then continue to construct their big project [wind turbine]. In fact, they first have to run into a problem, for example: "We don't know how to make electricity." They get frustrated, and that is when we present the practical "circuit" learning cycle. When you present them with a solution at precisely that moment, they are much more inclined to pay attention and understand how to do it than when you randomly present a lesson on electrical circuits.*

<u>*Student learning*</u>

Throughout the two observed lessons, considerable *interaction* occurred between the students (C7). Tasks were conducted in pairs. The students had to deliberate about the approach to be adopted, the allocation of duties and the solution for the problem. In addition, during the TLC, students had to discuss the information collected and the quality of it. Jan divided the students in groups and, via this, he saw that students learned to cooperate with different parties. During their cooperation, the *input of fellow students was crucial* (C8). An example of this was visible in the observed TLC in which the students had to present the information gathered with regard to their particular learning question to the other students in the class. Students exchanged knowledge with each other as opposed knowledge being transferred linearly from the teacher to the student via instruction. Jan mentioned the following as a motive for doing this.

> *Students can often explain things better and more easily to each other in order for the other students to understand. […] And the student who does the explanation practices with the explanation and presentation of things.*

The students also often helped each other with the use of certain ICT tools. On these occasions, Jan was more reserved. Jan's aim was to have students *acquire knowledge and skills by working in an active and exploratory manner* (C10). During the TLC, students had to search for and discover information themselves. Jan would point out relevant concepts and thus make sure that a broadening and deepening of the students' knowledge occurred. He asked a lot of questions and had the students thus explain certain principles themselves. Jan knew exactly which direction he wanted the students' learning to take. During the observed PLC, the students themselves tested whether certain solutions worked or not. They practiced with the application of skills. Jan improved the effectiveness of learning by giving the students suggestions or tips to improve their product and/or skills. During both of the observed lessons, the students and their learning questions and products stood central. Initially, in the TLC Jan provided support with the definition of things and deepening of the information gathered. Thereafter, however, he had the students work more autonomously. At this stage in the students' learning, he *stimulated them to think up solutions on their own* (C11).

> *You shouldn't make it too easy for them, because then they will immediately… I used to do that too sometimes: When I didn't feel like doing something [as a student], I simply used to say "I don't get it." The teacher would then explain things and I could copy that. This is something which I want to prevent from happening. First, they have to try to find things out for themselves. And when they have found things out, you have to compliment them for that, of course.*

Another critical characteristic of Jan's teaching was *an emphasis on reflective learning* (C12). Jan encouraged the students to think critically about, for example, the information found or the approach adopted for a task. He made the students think by asking questions and, in such a manner, fostered deeper learning. Other techniques used by Jan to make students reflect were the log in which they had to summarize what they did during the lesson and what they planned to do in the next lesson; at the end of the PLC, the students also had to reflect upon how the lesson had gone.

*Types of guidance*

The nine types of possible guidance as described by de Bruijn et al. (2005) were all visible in the two lessons observed. Jan started his lessons with very brief whole-class *instruction* (G1). Thereafter, he helped the students get going via the provision of one-on-one instructions. In the TLC, he walked around the classroom and asked the pairs of students what they were doing. When necessary, he would guide the students in a different direction with the introduction of certain concepts or the presentation and discussion of examples with the students. When the students had adequately answered his questions, Jan would then end the conversation with a remark such as: *"This is what you are going to investigate now."* As a result, the students were able to search for information in a more focussed manner. In the PLC, Jan mainly gave instructions with regard to the task approach, materials which the students were allowed to use and relevant tools. In addition to this, Jan would *demonstrate* certain techniques (G2) during the PLC. For example, Jan regularly demonstrated the best manner to saw and sand. Jan noted the following with regard to the need to switch to demonstration at times.

> *That is related to safety. Look, when they do something wrong and saw their fingers off doing so…Obviously, we don't want that to happen. When dangerous situations emerge, I intervene immediately. And when they handle materials the wrong way, too.*

In the TLC, demonstration played a much smaller role, as did *thinking aloud* (G3). At most, Jan assisted the students with their brainstorming by thinking aloud. Sometimes he asked questions that came to his mind in response to their input. Jan *allowed autonomous student work* for a long time during the observed lessons (G4). He made students think up their own learning questions and made them find their own answers to these questions as well. In the PLC, students also had to create and build their own designs. Jan fostered autonomous student work by answering their questions, providing hints, helping them search for materials and carefully monitoring their progress.

> *First I let them muddle along a little, until they get stuck completely. Yes, and when they really don't succeed at reaching the core of what is required, then we redirect them a little.*

The muddling which Jan mentions did not last long. This is because Jan provided *active support* (G5). In the TLC, he initiated the provision of indications to the pairs. By posing questions, he often indicated what information had to be found still. He frequently asked questions to check that the students understood everything. He provided tips for useful search words, mentioned different situations to which a certain principle applied as well and he often had his students explain things in order to practice for the presentations they were going to give. During the PLC, Jan also provided numerous suggestions aimed at the most efficient approach to making a wind turbine. In such a manner, Jan could be seen to often *coach* his students during the observed lessons (G6). He also guided the learning process by indicating that the students were expected to discuss and make arrangements for the allocation of tasks. As stated earlier, Jan always made sure that the students were headed in the right direction.

> *So I give them tips. I will never immediately give the answer. I do send them in the right direction.*

Given that Jan provided active support, he *provided help when necessary* relatively less often (G7). As the lesson progressed, Jan increasingly allocated greater responsibility to the students. A clear difference was also visible between the TLC and the PLC: in the PLC, Jan would often answer the students' questions directly; in the TLC, in contrast, he typically reacted with a counter-question. Jan generally paid attention to the quality of the students' learning and their progress via *evaluation* (G8) and *feedback* (G9). Feedback occurred in combination with coaching. Jan frequently indicated when the students were on the right track or information was still missing, for example, and he would coach the improvement of their activities. Evaluation occurred in the form of comments on intermediate products. Jan would give his opinion regarding a particular state of affairs or mention possible points for improvement. At the end of a lesson, this was done for the whole class.

*Findings based upon the interview with four students*

The students reported that they had learned a lot during the "sustainable energy" project. For example, they reported having practiced certain skills such that they were now more able to apply these. They noticed that the teacher, Jan, gradually set the bar higher and higher for assessment of their performance. In general, the students perceived the tasks to be performed as useful. The students also recognized certain principles and concepts and were able to mention examples of other contexts in which these were applicable. The students were able to recognize relevant *content* from other subjects in the project. In addition to this, they were able to see the relations between the more theoretical and practical learning tasks (C2).

> Interviewer: *But is it true that you can make use of the information you looked up in the end?*
>
> Student*: Yes, because asking that [learning] question, that's something we do for the benefit of making the product. For example, our question was how transmission works and that can be used in our own model.*

The students liked the fact that their IT education was student-centred and that they often had to explain things to each other (C8).

> *We all had to search for something different and give a presentation on it. That way, you learn how to do something with the whole class and everybody does something. I think that's handy because the...for example, you look for information in threesomes and then you have information about five topics or so. You exchange the information found, and*

*you thus learn about things from your fellow students, don't you? [You] learn more easily as well. Those [students] talk differently. A teacher can use all kinds of difficult words…a student doesn't do that.*

The students indicated that they often learned actively and autonomously (C10, C11 and G4). Jan's role was to provide sufficiently active support or help as necessary. This was done by indicating, for example, what the students could do to improve their product (G5, G7). The students were aware that, in order to properly guide them, Jan had collected a great deal of information in advance but nevertheless let the students discover things to the greatest extent possible on their own.

*You yourself learn how to look something up independently, so to speak. For example, you have to search four websites and, on every website, you find something and sometimes something double. In such a manner, things stick with you. Or at least better. On one website, you read something you don't understand and on another site that part you didn't get is explained.*

One of the students called the manner in which the IT programme was designed "learning by investigation" (C10). Together with another student, he characterized Jan's teaching as follows.

Student 1: *At one point, it was about water or something like that. Then he said "what do you want to know?" and we made a round in the class. The questions [generated] were divided and, in such a manner, you learned about something you always wanted to know about. You got the chance to look into that.*

Student 2: *[When guiding students] he focuses on what you already know.*

Interviewer: *And all of a sudden he mentions a term or concept or so…*

Student 2: *Yes, that's right. And then you understand it […].*

Student 1: *Yes and sometimes when he provides a guideline, you think: "What on earth do I have to do with it." Then you start to – we do everything together – talk about it with your team-mate and then at one point…But it all costs a half-an-hour, an hour or so and then with hindsight I sometimes think: "Isn't it better to immediately tell us?" But on the other hand, we've got the time.*

Student 2: *When the teacher immediately tells, you only know one thing but when you search yourself, you see all kinds of other things at the same time.*

Student 1: *You actually learn by investigating.*

The students considered most of the lessons being taught by one and the same teacher to be an advantage. The teacher knew exactly what the students were doing at a given point in time. Other positive points mentioned by the students were the freedom given to decide what to do and the use of laptops. Although the students recognized the usefulness of the more theoretical TLC's, they would prefer doing practical work more often. In addition, the students reported feeling that a theme was sometimes dealt with for a very long time.

## 6.4 Conclusions and discussion

The purpose of this study was to gain insight into the relations between the characteristics of a good practice of a PVSE learning environment and the type of guidance provided by the teachers, on the one hand, and the learning processes of the students, on the other hand. The two teachers involved in this in-depth, qualitative study appeared to implement similar characteristics in their teaching. Some differences which were nevertheless likely to positively influence student learning were also observed between the teachers and the characteristics of the learning environments they created.

Harry can be characterized as a very enthusiastic teacher. When the students set out to design something, Harry continually assisted them in their thinking. The provision of active support and coaching were the types of guidance preferred by Harry who anticipated potential problems and thereby kept the learning process on track. The students were expected to learn increasingly more independently. Harry often had students experiment in order to have them discover critical principles and functions on their own. An important characteristic of Harry's teaching is that it is highly student-centred and that the students' own designs constituted the starting point for their learning. Harry only assisted the students with their designs, which was found to create student motivation. The actions of Harry were largely intentional. In the interviews, he was able to label the relevant starting points for his teaching. He could also provide clear explanations for his behaviour.

Jan can be considered a reciprocal teacher (Palincsar & Brown, 1984): when guiding students, he tended to pose counter-questions as opposed to direct answers to their questions. In such a manner, Jan can be seen to deepen student learning. In the counter-questions and examples Jan mentioned, he raised critical concepts and principles. The students were then left to seek an explanation for the concepts and principles themselves. Jan provided even greater active support than Harry. In such a manner, he guided students in the right direction. Jan obviously came to the lessons well-prepared and knew exactly how to lure students in a particular direction. The content of Jan's lessons was determined at least in part by input from students. That is, the questions of students provided the basis for their own learning. In addition to having to search for information themselves, the students also had to present and explain their findings to the rest of the class. The atmosphere in Jan's lessons was very pleasant and relaxed. In the interviews, Jan repeatedly pointed out elements of whole-task teaching and appeared to deeply value this characteristic of a learning environment.

In general, a number of successful points seem to stand out. The structure of the IT curriculum was solid and elaborated carefully. A whole-task learning model involving authentic practice-oriented themes and tasks to elicit meaningful learning was clearly visible. The learning environment was very rich: there were many learning possibilities for the students to choose from and many sources of information, teaching aids and places to work which created a variety of learning opportunities. There was nevertheless a clear structure due to the seven- and four-step learning cycles associated with the problem-based learning approach used in the different IT projects. This structure might very well have helped the PVSE students who usually find it difficult to regulate their learning (van der Neut, Teurlings, & Kools, 2005). The teachers in the IT programme monitored the achievement of PVSE core goals and checked to see that all of the relevant competences were given plenty of attention. Both the students and the teachers were remarkably motivated to participate in the experimental IT project which could be due, at least in part, to the fact that they participated voluntarily.

Although stimulating characteristics appeared to predominate in the learning environments studied here, some hindering factors were also present. With respect to the content of the education, the teachers noted that it was difficult to organize excursions and let the students work in real companies. This was judged to be a pity as both characteristics could provide extra motivation for students. With regard to the development of the IT programme and associated projects, some complicating factors also came to light. For example, the time available for development was limited which required teachers to invest more of their spare time than desired and consult with each other less than desired. The teachers nevertheless experienced the developmental tasks as challenging and would therefore like to see the development of the IT programme and projects allocated a fixed and larger team of teachers. At first, only those teachers who volunteered to participate were involved in the programme. From the third year of the programme on, however, teachers who had not participated in the development of the programme and had not opted to participate also taught the IT students. According to the two teachers interviewed for purposes of the present study, this sometimes gave rise to friction.

The IT programme was selected for consideration in the present study in light of the results of prior research (see Chapters 4 and 5). The students in the IT programme were found to have high-quality learning processes (i.e., learning-oriented goal orientations and deep information-processing strategies). Their knowledge was also developed to a particularly large extent. In the present study, some possible explanations for this uniquely high level of student learning were generated. First, the students were selected to participate in the IT programme on the basis of their motivation and intelligence. They were all studying at the highest level of PVSE and had a particular interest in innovative technology. Second, the emphasis in the IT students' learning activities appeared to be on cooperative, autonomous, active and exploratory learning. The students were not given a recipe book in which the steps to be taken for the conduct of a particular task are outlined in detail although this is quite customary in PVSE schools. Instead, the IT students had to structure and interpret information coming from a variety of sources themselves, and this can only be done appropriately when deeper levels of information processing occur. Third, the students were not left completely on their own in doing this. The teachers, rather, played a large role in the learning processes of the IT students with the provision of active support and coaching (cf. Kirschner, Sweller, & Clark, 2006). Fourth, the students always performed tasks which clearly related to authentic contexts, and this can be assumed to result in such learning activities as the relating, structuring and concrete processing of information and easier transfer to novel contexts (de Bruijn et al., 2005). In addition, the IT programme themes, projects, theoretical learning cycles and practical learning cycles were carefully connected to each other and a whole-task learning model was clearly visible. Opportunities to practice and to recontextualize learning content were thus created (van Oers, 1998). Fifth and finally, the manner in which the students were assessed corresponded to the manner in which their education was organized. For example, the students really had to understand the information they assembled to answer their own learning questions and adequately present and explain the answers to their questions to the remainder of the class. Furthermore, a list of underlying competences (i.e., knowledge, skills and attitudes) constituted the basis for the assessment of the students but was also used by the teachers during lessons to give their students feedback.

Perhaps the real difference between the good practice examined in the present study and other learning environments lies in the student guidance and personalities of the teachers. The teachers in the good practice had both played a major role in the design of the learning environment for the IT students and development of the relevant curriculum from the perspectives of IT and PBL. The question is whether all teachers are capable of working in an environment where students are expected to learn in a highly self-directed manner. Guiding students in competence-based learning environments requires giving the students greater freedom in what and how they want to learn, which might be difficult for those teachers who are accustomed to giving mostly whole-class instruction and following a course book in doing this. Moreover, giving students greater freedom does not imply a smaller task for the teacher. In fact, the contrary may be true: students who are given a greater freedom of choice and less whole-class instruction may require more active support from their teachers. Such active support will concern not only the student's learning process but also the content to be learned. The teachers in the good practice examined in the present study were very frequently and actively involved in helping students to improve their competences and acquire the knowledge, skills and attitudes needed to do this.

In closing, this study was carried out at a single school and addressed the conceptions and behaviour of only two teachers. This obviously has consequences for the generalizability of the results. However, in-depth insight into how the implementation of various elements of competence-based education in PVSE can work was provided by the results of this study. We believe that this information may be very useful for other schools dealing with the difficulties of adapting their education in the same direction as the good practice school investigated here.

# CHAPTER 7

# Conclusions and discussion

## 7.1 Brief overview of the research project

In the research described in this dissertation, the learning of students in competence-based Pre-Vocational Secondary Education (PVSE) was investigated. The general research question was: *What are the relations between the goal orientations, information processing strategies and knowledge development of students in competence-based PVSE?* In order to address the general research question, four more specific research questions were further posed (see Chapter 1). Suitable methods to measure the main variables in this research were investigated first (see Chapters 2, 3 and 4). Next, the associations between the main student learning variables and the characteristics of a variety of competence-based PVSE learning environments were investigated (see Chapters 4 and 5). A structural model depicting the relations between the preferred goal orientations, preferred information processing strategies and knowledge development of the PVSE students was also formulated and tested. Finally, an in-depth qualitative analysis of two teachers' conceptions of competence-based education and the actual types of student guidance provided by these teachers was undertaken in a school judged to be a "good practice" case of competence-based PVSE (Chapter 6).

## 7.2 Main findings and conclusions

In the following sections, the most important findings and conclusions for each of the four research questions will be summarized. Thereafter, some general conclusions about the whole study will be presented.

### 7.2.1 Instruments for the investigation of goal orientations, information processing strategies and development of knowledge (research question a)

With regard to the *goal orientations* of students in PVSE, the utility of three available instruments was tested for the investigation of such: a questionnaire, a semi-structured interview and a sorting task (see Chapter 2). The questionnaire was considered, because a questionnaire is generally regarded as an efficient means to collect data from a large number of participants. A questionnaire could thus be used — within the context of the present research project — to generate quantitative information about the goal orientations of students. The conduct of interviews was considered because an interview allows one to pose open-ended questions, probe for details, request clarification and ask for further explanation. Given that both the questionnaire and interview instruments investigate the goal orientations of students in a rather indirect manner, a sorting task which can be used to directly access and link the goal orientations of students to their actual task performance was also tested. Via the administration of a sorting task during the performance of a learning assignment, data is directly collected on the learning goals which the students actually have in mind during the performance of a task. More specifically, the students were asked to pick a card to indicate the type of goal on which they were working at several points during the performance of a task and to reflect upon the selected goal.

For each of the instruments investigated, the preferred goal orientations for each student were next determined. The preferences of each student on the different instruments were then compared, and a conclusion was drawn with regard to each student's *general* goal orientation (i.e., the most frequently occurring goal orientation across the three instruments). More importantly, the most suitable instrument to assess the goal orientations of PVSE students could be determined on the basis of these outcomes. That is, the instrument showing the most conclusions similar to the general orientations of the individual students, but also displaying high reliability and high construct validity, was judged to be most suitable.

The questionnaire was found to be the most suitable instrument to investigate the preferences for certain types of goal orientations of PVSE students. The questionnaire produced the smallest number of discrepant goal orientations when compared to the general goal orientations of the individual students. In addition, the reliability of the questionnaire was found to be sufficient with a Cronbach's alpha of .85 for a mastery orientation, .80 for a performance orientation and .72 for a work-avoidance orientation (n=49). The interview provided relevant supplementary information with regard to the learning goals of the students and the motives underlying these. In other words, the questionnaire and interview results appeared to correspond best to the general goal orientations of the students as reflected by the outcomes for the three instruments. An interrater reliability of .92 was also found for the coding of the interviews. The sorting task was found to produce the most discrepant results. The results of this instrument did not correlate significantly with the results of the questionnaire or the interview, while the latter two did show a high correlation. Given the more sound psychometric properties of the instrument *and* the practical advantages (i.e., efficiency) of such, it was decided that the questionnaire instrument is best suited to investigate the goal orientations of students in PVSE.

With regard to *information processing strategies*, the utility of three available instruments was again tested for purposes of the investigation of such among PVSE students: a questionnaire, a semi-structured interview and the think-aloud method (see Chapter 3). Questionnaires are generally deployed when sufficient knowledge exists with regard to the most relevant variables to be investigated. A number of questionnaires have been developed to investigate the information processing strategies and preferences of students in educational contexts other than PVSE contexts (e.g., Entwistle & McCune 2004). Given that the aim of our efforts at this stage in the present research project was to determine if the administration of a questionnaire was suitable to investigate the information processing preferences of PVSE students, an already existing questionnaire was adapted for this purpose (Vermunt, Bouhuijs, Piccarelli, Kicken, & Andree, 2006). A semi-structured interview was also tested as the conduct of interviews can provide extensive information and qualitative insight into the preferences of students for different information processing strategies. Finally, the think-aloud method was tested as such a procedure provides a relatively direct measure of the information processing preferences and predispositions of PVSE students. Students were encouraged to think aloud during the actual conduct of a learning task. The think-aloud method can produce a rich array of data on the processing strategies of students by asking them to continually state what they are thinking (i.e., think out loud) (cf. Ericsson & Simon, 1998).

Per instrument, a conclusion was drawn with regard to the information processing preferences of each student. A conclusion regarding the *general preference* of a student for a particular information processing strategy or combination of strategies was also then determined (i.e., the most frequently preferred information processing strategies when the preferences on the three instruments are combined per student). More importantly, the most suitable instrument to assess the information processing strategies of PVSE students could be determined on the basis of these outcomes. That is, the instrument showing the most conclusions similar to the information processing strategies generally preferred by the individual students, but also displaying high reliability and high construct validity, was judged to be most suitable.

Significant correlations were found between the results for the three instruments, which suggested that the three instruments measured largely the same aspects of the information processing preferences of students. The three instruments corresponded almost equally well to the general information processing preferences identified for the students. The questionnaire appeared to be the most accurate instrument and allowed easy classification of students according to their information processing preferences. The scales of the questionnaire showed sufficient reliability (Cronbach's alphas of .79 for deep processing strategies and .83 for surface processing strategies; n=49). The think-aloud method provided rich and direct insight into the information processing strategies preferred by students for a particular learning task and the frequencies with which these strategies were used. An interrater reliability of .84 was found for the coding of the student verbalizations produced using this method. The coding of the interviews showed an interrater reliability of .92 and the interview results largely corresponded to the results produced by the other instruments. However, the interview data lacked the expected richness and depth. Given the accuracy and ease of the questionnaire for the classification of students with regard to their information processing preferences, it was decided that the questionnaire instrument was best suited to investigate the information processing strategies and preferences of students in PVSE.

With regard to the *knowledge development* of students in PVSE, it was decided that traditional tests were not suitable to investigate the type of knowledge in question (see Chapter 4). That is, we were particularly interested in the elaborateness and organization of students' knowledge. In competence-based learning environments not only the reproduction of knowledge is of importance, but also the structure of the knowledge a student possesses, the elaborateness of that knowledge, and the relations established between concepts. In order to answer the general research question, the knowledge development of students had to be investigated across subjects, PVSE sectors and schools. Based upon a review of the relevant research literature, it was decided to adopt the so-called concept mapping technique to investigate the knowledge development of PVSE students. Concept maps are composed of knowledge in the form of concepts and the relations/links between these concepts (Novak, 2002). Within the context of the present research, concept maps were collected from students prior to their participation in a learning project which had a duration of eight to ten weeks and after completion of the project. This allowed comparison of the concept maps with regard to a core concept from the relevant project at pretest versus posttest and thus provided direct insight into their knowledge development. In the analyses of the concept maps, attention was paid to the number of nodes and links, the relevance and relative importance of the concepts included in the maps, the types of connections drawn between the concepts, the depth of the maps (i.e., number of layers) and the general content of the maps (i.e., clusters of concepts) (Liu, 2004; Mavers, Somekh, & Resorick, 2002; Ruiz-Primo, Schultz, Li, & Shavelson, 2001). These features provided information on the quality of the students' knowledge with regard to a particular topic over time and were well-suited to investigate the knowledge development of students in PVSE. The concept maps were evaluated by two raters that compared a student's pre-project and post-project concept map, using the criteria as a basis for giving an overall score on a Likert-scale about knowledge development. An interrater reliability (Cohen's Kappa) of .78 (based upon 188 out of 1179 concept map judgements) was found. The quality of the concept maps generated by the students on the second measurement occasion was also found to be significantly better than the quality of the concept maps generated on the first measurement occasion ($t=-6.351$; $p=.048$; $df = 811$). In other words, the concept mapping instrument showed growth in the students' knowledge. It can thus be concluded that concept mapping can be used to investigate the knowledge development of students in a competence-based PVSE setting.

Given that different PVSE learning environments were examined in this research project, it was necessary to investigate characteristics of the learning environments. With such information, it was possible to investigate the relations between characteristics of the learning environments and students' knowledge development (see Chapter 4). In order to characterize learning environments and classify them in terms of the extent to which they are judged to be competence-based, it was decided to use a questionnaire which was originally developed by de Bruijn et al. (2005). In research on learning environments, characteristics of these environments are often classified in dimensions. These dimensions typically constitute a dimension concerning the *content and organization* of the environment and a dimension concerning the *interaction* between persons (e.g., Moos, 1979;

Watzlawick, Beavin, & Jackson, 1967). In the present research, the characteristics of the competence-based learning environments were operationalized in similar dimensions, using the classification and the questionnaire of de Bruijn et al. (2005), consisting of a *content* dimension and a *guidance* dimension. The content dimension concerns the manner in which learning content is dealt with in the relevant learning environment; the guidance dimension concerns the different types of student guidance provided by teachers, such as coaching and providing feedback. The advantage of using the dimensions distinguished by de Bruijn et al. is that the dimensions were originally developed to investigate competence-based learning environments in vocational education. Most of the questionnaire scales showed to have sufficient reliability (Cronbach's alphas were between .60 and .86; see Chapter 4). Moreover, as expected and in line with the results of a study by de Bruijn and Overmaat (2002) significant correlations were found for some of the questionnaire scales, which indicated construct validity. On the basis of the preceding information and considerations, it was thus concluded that the teacher questionnaire was indeed suitable to investigate the characteristics of competence-based learning environments.

### 7.2.2 Structural relations between goal orientations, information processing strategies and development of knowledge (research question b)

After having identified suitable instruments to measure the goal orientations, information processing strategies and knowledge development of PVSE students, the structural relations between these student learning variables were next examined. A number of assumptions about how students learn in competence-based education provided the rationale for the creation of a model of the relevant associations. It was assumed, for example, that the learning environments for competence-based education should be designed to appeal to an intrinsic learning motivation on the part of students, mastery goal orientations and thereby the use of deep information processing strategies. Both this assumption and the various aspects of it have scarcely been examined in PVSE contexts. With respect to learning outcomes, the focus was on knowledge development. Knowledge is considered to be an essential component of competence and necessary to make adequate decisions in real-life working situations (van der Sanden, 2004). Little was known at the start of this research, however, about the role of knowledge in competence-based PVSE. The instruments determined as most suitable were used to measure the relevant variables.

The questionnaire scales measuring the goal orientations of 719 students showed sufficient reliability (Cronbach's alphas of .89 for mastery, .89 for performance and .73 for work avoidance). The average scores along a five-point scale were 3.56

for mastery, 3.03 for performance and 3.36 for work avoidance. The questionnaire scales measuring the information processing strategies of the students showed sufficient reliability as well (Cronbach's alphas of .82 for deep processing strategies and .73 for surface processing strategies). The average scores along a five-point scale were 2.71 for deep information processing strategies and 3.30 for surface information processing strategies. The average scores of the students along a five-point Likert scale for the concept maps were 2.77 at pretest and 3.06 at posttest.

The structural model formulated to characterize the relations between the goal orientations, information processing preferences and knowledge development of the students showed students' preferences for mastery and also performance goals to contribute to their use of deep and surface information processing strategies. A preference for work-avoidance goals negatively affected the students' preferences for deep and surface information processing strategies. Remarkably, a performance goal orientation exerted a direct positive effect upon the quality of students' posttest concept maps. It is certainly possible that performance-oriented students wanted to achieve well and therefore tried their best on the concept maps at the posttest. The use of surface information processing strategies was found to negatively influence the development of the students' knowledge. Preferences for deep information processing strategies did not affect the students' knowledge development. However, students' preferences for deep and surface information processing were also found to intercorrelate: the greater the preference for surface processing strategies, the greater the preference for deep processing strategies as well. It thus appeared that deep processing was necessary for surface processing to occur and vice versa. In addition, the quality of the pretest concept maps was found to positively influence the quality of the posttest concept maps, which suggested that the students' level of prior knowledge affected their later level of knowledge. The quality of the students' pretest concept maps further influenced their preferences for deep information processing strategies but in a negative manner: those students who initially created rather good concept maps showed a preference for relatively *less* use of deep information processing strategies. Taken together, these findings showed the relations between the goal orientations, information processing strategies and knowledge development of students in competence-based PVSE to be complex; not only direct relations but also indirect relations were found.

### 7.2.3 Relations between the development of knowledge and characteristics of the competence-based learning environments (research question c)

The purpose of the study presented in Chapter 4 was to determine the degree to which the development of student knowledge differed in PVSE schools which varied with regard to the manner in which and extent to which they had implemented characteristics of competence-based education. The implementation of characteristics of competence-based education was assessed via the administration of a teacher questionnaire. The knowledge development of the PVSE students was assessed via concept mapping. The questionnaire results showed the investigated schools to score low to medium on the extent to which they could be characterized as competence-based. More specifically, in 7 of the 14 learning environments investigated, at least some content or guidance elements of competence-based education were reported. In 5 of the learning environments, however, virtually no elements of competence-based were reported. Furthermore, only 2 of the learning environments could be characterized as mainly competence-based.

The results of correlational and multilevel analyses of the relations between competence-based education and the knowledge development of the students showed those students in learning environments with *fewer* characteristics of competence-based education to develop slightly more knowledge than those in learning environments with relatively more characteristics of competence-based education. The organizational characteristics of the learning environments were found to be distinctive for the development of knowledge. That is, the characteristics of the content dimension had a negative influence on development of student knowledge. More specifically, the *type* component of the content dimension, which indicates the degree to which the organization of the learning environment could be typified as potentially powerful appeared to negatively influence students' knowledge development to a slight extent. However, the presence of learning environment characteristics which were considered less powerful beforehand, that is characteristics considered more *customary* (i.e., more traditional), also negatively influenced the students' knowledge development. While the guidance dimension of the competence-based learning environment did not make a significant difference for the development of students' knowledge in general, a specific *growth* component did. When guidance was increasingly provided during the course of the students' educational careers in a learning environment, the students were found to develop more knowledge than did other students for whom this was not the case. The results of the multilevel analyses of variance showed the classifications of the learning environments (in terms of the degree to which they could be considered competence-based) and student gender to influence the students' knowledge development. Most of the differences in the development of the students' knowledge appeared to be due to differences among the students themselves. Nevertheless, about 20% of the variance occurred at the level of the learning environment, which can more effectively be influenced by teachers and curriculum developers. Based on the results reported in Chapter 4, it can be concluded that competence-based education did not produce purely positive effects on the knowledge development of students in the PVSE schools investigated, which is contrary to what was expected.

### 7.2.4 Characteristics of the learning environment and knowledge and behaviour of teachers regarding student guidance for promoting students' learning processes and knowledge development (research question d)

Regarding the development of students' knowledge in competence-based education (questions c) and the structural relations found to hold between the goal orientations, preferred information processing strategies and knowledge development of students (question b), a school which could be characterized as a "good practice" school for competence-based PVSE was identified (Chapter 6). The practices of two teachers (and their classes) in this school were then investigated in order to gain greater insight into the implementation of competence-based education. The study was carried out within the context of the competence-based projects the teachers designed. More specifically, an in-depth qualitative analysis of the two teachers' conceptions of competence-based education, the learning environment characteristics they implemented and the actual types of student guidance provided by these teachers was undertaken within the context of these projects.

The teachers had implemented very similar characteristics of competence-based education. One teacher could be characterized as very enthusiastic. When the students were busy with the design of something, he would continually help them with their thinking. This teacher clearly had a preference for such guidance activities as the provision of active support and the coaching of students with regard to their learning processes. The teacher would also anticipate potential problems and discuss these with students in order to keep the learning process at pace. The teacher also clearly expected the students to learn in an increasingly more independent manner. The type of education preferred by this teacher could be characterized as student centred, and exploratory learning played an important role in this. The other teacher could be characterized as a reciprocal teacher or, in other words, a teacher who presented counter-questions rather than answers to guide student learning. This technique appeared to deepen the students' learning as critical concepts and principles were often mentioned in the counter-questions. The students were encouraged to seek the explanations for these concepts and principles themselves. This teacher provided active support as well. The type of education provided by the teacher could be characterized as student-centred, with a focus on whole-task learning.

For both of the teachers, the conclusion can also be drawn that the structure of the curriculum was elaborate and solid. A whole-task learning model — involving authentic, practice-oriented tasks and themes that were connected to each other — appeared to elicit meaningful learning and to create opportunities to practice and recontextualize knowledge and skills. The learning environments were very rich. A fixed program order that was being part of problem-based learning provided a clear structure. Both the students and teachers were remarkably motivated to participate in the learning project — perhaps in part because participation was voluntary. The high quality of the learning processes of the students in *this* learning environment found in the quantitative studies presented in Chapter 4 and 5 might have been caused by several learning environment characteristics which are not yet common practice in PVSE. For example, the students participating in the learning project themselves had to structure and interpret information gathered from different sources, which can really only be done when using deep information processing strategies. Both of the teachers also played a large coaching role in student learning and clearly provided active support. Finally, the students always performed tasks which were somehow related to an authentic context, which is often assumed to stimulate the relating, structuring, concrete processing and transfer of information to different contexts. On the basis of these "good practice" insights, it can be concluded that a well-structured curriculum, the creation of opportunities for deep student learning and active teacher guidance contributed to the high quality learning processes of students revealed in the prior quantitative studies.

### 7.2.5 General conclusions

In many of the schools which participated in the present research, the learning processes of the students did not occur completely in the expected manner. With regard to the goal orientations of the students, most were oriented towards learning: the mastery orientation scale showed the highest average score (see Chapter 5). Nevertheless, the students indicated that they only strived to learn when the task to be performed was perceived as useful with respect to a future job (see Chapter 2). However, the interviews showed most of the students who participated in this research to have a rather limited view of what is relevant for their future professions. With respect to the information processing strategies preferred by the students, surface processing strategies were most often preferred, which cannot be considered a positive result. In the model formulated in one of the quantitative studies (see Chapter 5), in fact, preferences for surface processing strategies were negatively related to the development of knowledge. With regard to the associations between the characteristics of the learning environments and the knowledge development of the students, it was expected that students would develop more elaborate and better organized knowledge in competence-based learning environments (see Chapter 4). That is, the students were expected to connect and structure their knowledge better, make more links to the world outside the school and think more critically in learning environments with more competence-based characteristics. This expectation could not be confirmed by the results of our study. In fact, students developed slightly more knowledge in more traditional forms of education. From the quantitative studies described in Chapters 4 and 5, one "good practice" of competence-based education was selected in which the desired learning processes did occur. The characteristics of the learning environments and types of student guidance provided by two teachers in this good practice school were described in Chapter 6. It can be concluded that although the results of the studies described in this dissertation are somewhat disappointing, promising developments in the design and implementation of competence-based education *can* be detected in practice. As yet, these developments can be seen to be rather diverse and have varying success, but there are some examples of schools which have succeeded with the effective implementation of competence-based PVSE education. In general, however, the development of students' knowledge does not get the attention which it deserves.

## 7.3 Discussion

### 7.3.1 Goal orientations

The average goal orientation scores found on the mastery, performance and work avoidance scales differed from those found in the study using the original questionnaire (Duda & Nicholls, 1992). In our study with PVSE students, the highest mean score was found for the mastery orientation; in the Duda and Nicholls study of the school and sports goal orientations of college students, the work avoidance orientation was most preferred. In the Duda and Nicholls study, the mastery orientation was least popular; in our study, the performance orientation was least popular. The results of our study appear to be more comparable with the results of studies conducted within the context of traditional lectures in higher education (e.g., Elliot & McGregor, 2001; Harackiewicz, Barron, Carter, Lehto, & Elliot, 1997).

In the structural model we developed and tested (see Chapter 5), significant associations were detected between the goal orientations and information processing strategies of students. A mastery orientation showed the anticipated effect on students' learning processes. Those students with a mastery orientation showed both more deep and surface processing strategies, which is largely in keeping with the results of other studies of the goal orientations of students (Rozendaal, 2002; Vermunt & Vermetten, 2004). Work-avoidance goals were negatively associated with the use of both deep and surface processing strategies. Fortunately, in the study presented in Chapter 5, a work-avoidance orientation was found to be least preferred by the PVSE students. Perhaps it is still natural for at least a few students in adolescence to not have the intention to put a lot of effort into learning (Crone, 2008; Eccles & Midgley, 1990).

Prior to the conduct of the present research, performance-oriented goals were not expected to have a very positive effect on the preferences of students for information processing strategies or their knowledge development. Contrary to our expectation, a preference for a performance orientation was found to have a positive influence on not only a preference for deep processing strategies but also knowledge development. Comparable results have been reported in a review of the goal orientations of students in different educational contexts by Harackiewicz, Barron, Pintrich, Elliot, and Thrash (2002). In our study, a performance orientation, which reflects a desire to demonstrate ability and/or do better than others, was associated with optimal motivation and learning. It is likely that the performance-oriented students wanted to achieve well and therefore did their best on the concept map produced at posttest. Administration of a retention measure some three months later, for example, would be interesting to determine whether the observed effects have persisted or not.

The results regarding the goal orientations of the students studied here provide insight into where learning may start in competence-based PVSE. A reasonable amount of research has been conducted on the goal orientations of students in other educational contexts, including higher education (see Vermetten, Lodewijks, & Vermunt, 2001). Despite the practice-related knowledge of PVSE teachers, almost no information was available about the motivation and learning orientations of PVSE students. As such, this study provides support for the assumption that competence-based learning environments can foster an intrinsic learning motivation and associated goal orientations on the part of PVSE students.

### 7.3.2 Information processing strategies

In one of the quantitative studies (see Chapter 5), it was discovered that the PVSE students in competence-based education mainly used surface processing strategies, which was not expected beforehand. Competence-based learning environments are expected to foster the use of deep information processing strategies (Struyven, Dochy, Janssens, & Gielen, 2006; van der Sanden, 2004), but the finding that such learning environments do not necessarily elicit deeper information processing has been found in other studies as well (Gijbels, Coertjens, Vanthournhout, Struyf, & van Petegem, 2008; Struyven et al., 2006). Several explanations can be offered for the (continued) preference on the part of PVSE students for surface information processing strategies. First, it can be questioned whether PVSE students are actually capable of using deep information processing strategies, which entail the relating and structuring of information and critical processing of information. Based on the results of a different study of the cognitive learning of PVSE students, the conclusion can be drawn that such students *are* indeed capable of using such strategies (Rozendaal, 2002). In fact, in the study of Rozendaal a preference for deep information processing over surface information processing was found. The average scores on the deep processing scale were also higher in the Rozendaal study than in our study.

A second possible explanation for the preference for surface information processing strategies in largely competence-based learning environments may lie in the nature of the PVSE learning tasks themselves. It is possible that surface processing strategies are the only type of strategies required by the majority of tasks given to PVSE students. Most PVSE schools provide highly structured tasks to help their students regulate their learning, and this may stimulate the use of largely surface information processing strategies. Stated more generally, we suspect that the expectations of teachers with regard to the learning of their PVSE students and the specific characteristics of the PVSE learning tasks provided allow students to fulfil the demands of teachers and the learning environment with largely the use of surface information processing strategies (van der Neut, Teurlings, & Kools, 2005). Deep information processing may simply not be needed to perform the majority of the learning tasks which are part of competence-based PVSE projects. The promotion of deep learning is nevertheless identified as one of the starting points for competence-based education (Hmelo-Silver, 2004). The present findings thus suggest that this objective of competence-based education has yet to be realized. It is certainly possible that other types of learning tasks — in which students are stimulated to relate learning content to prior knowledge and experiences and also encouraged to think critically — may elicit the desired deep information processing.

Thirdly, the relatively low score on the preferences for deep processing strategies scale may also be related to the earlier mentioned problem related to the mastery goal orientation. A large part of the students indicated to prefer to pursue mastery goals, but they may do so in a very context-dependent and variable way. When interviewed about their goal orientations these orientations were found to be strongly related to the perceived importance of the particular learning task (see Chapter 2). When the utility of a task was highly valued in relation to future employment, students tended to show a desire to learn and perform well. However, very few learning tasks were valued highly. Given that the goal orientations of students determine — at least in part — their preferences for information processing, the relatively low perceived utility of many PVSE tasks may contribute to the use of mostly surface information processing strategies by students in PVSE. That is, the learning tasks they were confronted with were simply not perceived as sufficiently interesting or useful to trigger the deeper processing of information.

Finally, the lack of a preference for deep information processing on the part of the PVSE studied here may also be related to the use of meta-cognitive and affective strategies. Oemar Said (2009) recently found that, as a result of the implementation of elements of competence-based education, the use of meta-cognitive strategies by VET students generally decreased. In learning environments research, moreover, a downward trend in student motivation during the course of a school year and in their school careers has often been observed (van Amelsvoort, 1999; Bergen, van Amelsvoort, & Setz, 1994; den Brok, 2001; Oemar Said, 2009). As the use of sufficient meta-cognitive and affective strategies can be considered a precondition for cognitive learning, limited use of such strategies may have influenced the use of deep or surface information processing strategies and even the knowledge development of PVSE students.

In the structural model we created and tested, the preferences of the students for deep and surface information processing strategies were found to positively correlate. It is likely that some amount of surface information processing is — at least in part — a precondition for deeper information processing. Stated differently, a threshold level of information and organization of such information may create space in working memory and thereby allow learners to process additional incoming information more deeply (Driscoll, 1999). Comparable results have been reported by Rozendaal (2002), who indicated that surface processing on certain tasks to lead to deeper processing in the future. Given that PVSE can be considered a preparatory form of education, the focus is logically upon the acquisition of basic knowledge and mastery of some fundamental procedures for later expansion within the context of the student's Vocational Education and

Training (VET). From a learning psychology perspective, however, a focus on *only* surface learning in PVSE does not make much sense. Relative to deeper processing strategies, the use of surface processing strategies has been shown to produce less positive learning results and less transfer to new contexts (van der Sanden & Teurlings, 2003; Tuomi-Gröhn & Engeström, 2003). Students should thus be encouraged to use both deep and surface processing strategies throughout their PVSE and VET school careers from the beginning of their PVSE careers. The use of different types of information processing strategies is, in this light, assumed to be most effective for purposes of learning (cf. Rozendaal, 2002).

The results of our research partly correspond to the results of other research on the information processing strategies of PVSE students. Some differences between the cognitive learning processes of PVSE students and students in other educational contexts were also detected. The results of other research showed a few learning environments to succeed at fostering the use of deep information processing strategies by students (Gijbels et al., 2008; Struyven et al., 2006). Our research, however, shows competence-based PVSE learning environments to be even less successful. The results of our research thus point to the urgency of developing learning environments which effectively elicit deep information processing on the part of PVSE students. The study presented in Chapter 6 might provide a productive starting point and suggestions for how to make competence-based education work in PVSE.

### 7.3.3 Development of knowledge

As expected, the students' preferences for particular goal orientations and information processing strategies influenced their knowledge development. In addition to a direct effect of a performance orientation on knowledge development, the mastery and work-avoidance orientations exerted small but indirect effects on knowledge development. Also as expected, a preference for the use of surface information processing strategies showed a direct but negative association with the quality of the students' concept maps after completion of the competence-based learning projects (i.e., knowledge development). In contrast to our expectations, no direct associations were found between a preference for deep processing strategies and the quality of the students' posttest concept maps (i.e., knowledge development). Once again, several explanations for this unexpected finding are available but the most probable cause may be the specific PVSE learning context not eliciting or stimulating deep processing to a sufficient extent.

Along these lines, in Chapter 4, the relation between the extent to which the learning environment could be characterized as competence-based and the students' knowledge development was described. The students developed knowledge during the learning projects, but the characteristics of the learning environments did not greatly influence their knowledge development. The knowledge development of students is – as generally concluded in studies of school effectiveness — mainly influenced by their own characteristics (Scheerens, 2000). In addition to their goal orientations and preferred information processing strategies, such student characteristics as the meta-cognitive and affective learning activities which they undertake have been found to affect their knowledge development (Oemar Said, 2009). According to Creemers (1994), moreover, school achievement is largely determined by student motivation, which may thus — in addition to the meta-cognitive and affective activities of students — influence their knowledge development as well. The findings of the in-depth study described in Chapter 6 further speak in favour of this as greater knowledge development was found to occur in the good practice learning environment in which student motivation and self-regulation were enhanced.

Slightly *less* knowledge was found to develop for those students in learning environments with *more* characteristics of competence-based education in the present research. The question, then, is whether competence-based education provided by the schools participating in the present research can be considered an effective form of education. More generally, is competence-based education suitable for PVSE students? An important point to keep in mind in answering these questions is that competence-based education was not yet daily practice in many of the participating schools. Some of the schools had only been implementing characteristics of competence-based education for about a year. Teething problems, which tend to be part of any innovation process (Oemar Said, 2009; Windschitl, 2002), might obviously influence student learning in a less positive manner. Moreover, in some of the schools, the teachers implementing competence-based education appeared to forget some critical aspects. For example, schools must pay attention to not only the manner in which the curriculum is organized or re-organized but also to adequate student guidance. Not only regular guidance but also diverse forms of guidance should be supplied within the context of competence-based education (cf. Gibbs & Simpson, 2004; Hattie & Timperley, 2007). In support of this, a positive correlation has been found in our research between the knowledge development of students and the provision of increased guidance during their school careers, which suggests that it might make sense to provide all forms of guidance during the entire educational trajectories of students and to carefully monitor their progress as well. The question which remains, of course, is whether all teachers are capable of doing this. The results of the present research suggest that many teachers find it particularly difficult to carry out certain essential guidance activities such as evaluation of the quality of the learning results and the provision of feedback during the conduct of activities; these essential aspects of teacher guidance occurred the least of all guidance aspects. In addition, the results of the present research suggest that a balance between the more innovative elements of competence-based education and more traditional elements of education may be most suited for the organization of PVSE learning environments. Most of all, schools must keep in mind that knowledge is essential — just as the development of skills and attitudes — for the development of competences. Without sufficiently elaborate and adequately organized knowledge, a professional cannot act competently. Perhaps competence-based education today mostly leads to projects which are judged by students as “fun” or “entertaining” but have lost sight of critical core curricular objectives.

In ongoing discussions of the effectiveness of competence-based education, a comparison is logically made to more traditional forms of education. Drawing upon such a comparison, it is possible that competence-based education leads students to organize their knowledge *less* adequately as a result of the absence of direct instruction while direct instruction is still believed to constitute a very effective form of student guidance (Hattie & Timperley, 2007; van der Werf, 2006). Some schools have already started to take these findings into account and now use instruction as a form of guidance within the context of competence-based education; that is, different forms of guidance are combined in order to achieve diversity and provide students with the necessary variation (de Jong, 2006; Simons, 2006). It is important to keep in mind that in competence-based vocational education, practical knowledge which can be used in actual working situations is of key importance; practical knowledge can be best developed in authentic learning environments (Boshuizen, 2003); and direct instruction cannot — as a consequence of this situation — be the only type of guidance provided by teachers. Students, themselves, must acquire experience with knowledge, skills, and attitudes but teachers will still have to guide them and continually engage them in explicit knowledge building.

## 7.4 Implications for practice

Use of the instruments employed in the present research can supply PVSE schools with useful information. The instruments used to specify the goal orientations and information processing strategies of students can be used by teachers to gain insight into the motives and learning processes of students. Of course, a number of other instruments may also be called upon for this purpose, including tests of student motivation, meta-cognitive strategies and affective strategies. The concept mapping method can be used by teachers to assess the quality and development of the type of students' knowledge that is critical in competence-based learning environments (see Chapter 4; Akinsanya & Williams, 2004). Concept mapping can obviously be used in combination with other instruments aimed at the measurement of the skill and attitude aspects of competence (cf. Baartman, 2008; Gulikers, 2006). The teacher questionnaire used to determine the extent to which a particular learning environment can be characterized as competence-based can also be deployed by schools for the professional development of teachers. That is, the questionnaire can be used to gain insight into the strong and weak points of the competence-based learning environments created by a teacher. The outcomes can be used for reflection, to modify the characteristics of the learning environment, to improve the guidance provided by teachers and to help teachers coach each other. The teacher questionnaire can best be combined with assessment of student perceptions of the learning environment as student perceptions have been found to relate more strongly to student learning outcomes than the perceptions of external researchers, teachers or school management (Fraser, 1998; Wubbels, Brekelmans, den Brok, & van Tartwijk, 2006).

As stated before, a noticeable number of the students in our research had mastery as the goal of their learning (i.e., showed a preference for a mastery goal orientation). This can be considered a positive result although the presence of such a mastery orientation was found to strongly depend upon the perceived utility of the task. The students appeared to have a very limited view of what was relevant within the framework of their training for future employment. The question, then, is how can teachers take the limited view of students on task utility into account? Given that a mastery orientation has been shown to promote a preference for the use of deep information processing strategies, this type of goal orientation should be encouraged. Most schools participating in the present research succeeded in fostering a mastery goal orientation, but they did not succeed at fostering the use of deep processing strategies. In the "good practice" case of competence-based education (see Chapter 6), preferences for a mastery goal orientation *and* the use of deep processing strategies were fostered. The two teachers succeeded at this using different learning environment characteristics. For example, the students participating in the investigated learning environment were selected for participation on the basis of —among other things — motivation. However, little schools have the possibility to do this. Conversely, other characteristics such as an emphasis on cooperative, autonomous, active and exploratory learning can clearly be implemented in other PVSE schools as well (de Bruijn et al., 2005). In the good practice case of competence-based education, the students frequently cooperated in groups of different sizes and worked on tasks which required active exploration for the design and construction of something. In doing this, the students had to relate and structure information coming from different sources, think critically about what they did and process information in a concrete manner. The results were high quality learning processes and clear knowledge development in this school relative to the other schools which participated in the present research.

In the good practice school described in Chapter 6, the use of both deep and surface processing strategies may also have been promoted by the organization and presentation of the learning tasks for the students. The learning tasks were not presented in a very stepwise manner as a stepwise manner of task presentation is known to prevent the application of deep information processing strategies. Besides from the basic underlying steps of problem-based learning, the things the students had to do were not spoon-fed to them, which may have required them to apply more deep information processing strategies. The students in the good practice were not given a “recipe book” with clearly structured recipes for how to perform various tasks. Instead, the students had to organize and interpret the information coming from a number of different sources themselves, which can only be done adequately when deep information processing strategies are applied. These same students always undertook tasks which were somehow associated with an authentic context which is supposed to promote the connection and structuring of knowledge, the concrete processing of information and the transfer of knowledge and skills to novel contexts (Guile & Young, 2003). It would be worthwhile for other schools to examine the manner in which they structure their learning tasks and the effects of this upon student learning.

Also, in the good practice school described in Chapter 6 the knowledge development of the students was probably promoted by the structure of the curriculum as a whole. Competence-based education was clearly considered more than just the conduct of fun projects for students to learn things more or less by coincidence. In contrast to the approaches of many schools, attention was explicitly devoted to what knowledge was of relevance for the careers of the students and how this knowledge could best be organized together with the relevant skills and attitudes within the curriculum. In the good practice school, core concepts to be studied during the four-year programme and themes associated with these core concepts were identified. The themes were translated into projects to be handled in accordance with the principles of Problem-Based Learning (PBL) (Hmelo-Silver, 2004). The themes were connected to each other and a whole-task learning model was used to do this. Of course, PBL is not the only form of education which allows one to address learning content in a structured, yet student-centred manner. An advantage of PBL is that the learning cycles which are part of this instructional method can provide a framework for more self-directed and — as already mentioned — active, exploratory learning. In PBL, the learning cycles constitute a *process* which leaves room for the handling of the actual learning *content* in a sufficiently deep manner. There is also some empirical evidence for significant associations between deep learning, knowledge development and a learning environment with characteristics of PBL (Blumberg, 2000; Dochy, Segers, van den Bossche, & Gijbels, 2003).

Much profit can be gained with regard to how students can best be guided by teachers in competence-based education. The role of the teacher as a coach in student learning can certainly be shaped better (Beijaard, 2009; Biemans, Nieuwenhuis, Poell, Mulder, & Wesselink, 2004). Coaching, for example, does not entail leaving students on their own and simply watching to see what happens. To the contrary, the guidance of students in a competence-based learning environment requires the teacher to play active and very different roles: the teacher must provide feedback, active support and help when requested. Teachers must scaffold learning content (van de Pol, Volman, & Beishuizen, 2008), and they must coach students on the planning of their learning trajectories and careers (Mittendorff, Jochems, Meijers, & den Brok, 2008). Given that students in competence-based education do not all perform the same learning task at the same time, it is important that the teacher also knows exactly what a student is doing at a given point in time. Only then is the teacher in a position to introduce and explain relevant concepts and principles, refine and improve the thinking processes of students and help students structure the knowledge, skills and attitudes being acquired within a rich learning environment (see Chapter 6). The capacity of a teacher to guide and coach student learning may depend, at least in part, upon the teacher's personality and his or her conceptions of teaching and learning. A critical question is whether every teacher will and should be able to adopt and perform the role. Teacher training institutes might fulfil an important function along these lines. The curriculum of teacher training should be adapted to align the current curriculum with the situation in PVSE schools and give future teachers plenty of opportunities to develop their competence with regard to new teacher roles and tasks (van der Sanden, 2005).

In the Netherlands, a parliamentary research committee investigated the functioning of education and its reform over the past few decades (Dijsselbloem et al., 2008). The main recommendation of this committee was to "stop reforming education". In our opinion, this is not a wise idea with regard to competence-based education as — although the results of our research show less than complete success as yet — the development of competence-based education was *initiated* by teachers and only later adopted by school management and policymakers. This is in marked contrast to many of the innovations investigated by Dijsselbloem et al. and, although competence-based education is now being imposed by many school managements and policymakers, the content and intentions underlying competence-based education are still largely embraced by a large part of the teachers. In many schools, the principles of competence-based education can be considered a framework which gives teachers numerous degrees of freedom for the design of their own learning environments. Competence-based education can be construed as a reform aimed at addressing specific problems in vocational education, including early drop-out and low student motivation. The results of the present research show competence-based education can indeed be effective in some schools, taking into account that it takes time for an innovation to be implemented and flourish (Oemar Said, 2009). Our main recommendation is thus to continue with the implementation of competence-based PVSE — provided that attention is paid to not only the content and organization of the curriculum, but also to the provision of sufficient student guidance.

## 7.5 Limitations and suggestions for future research

Finally, some critical remarks regarding the study conducted can be offered at this point. These remarks can then be taken into account in future research.

In the present research, the cognitive learning and knowledge development of students in competence-based PVSE was the topic of study in part because the focus of most research on competence-based PVSE has been upon the meta-cognitive and affective learning of students and the development of their skills and attitudes (Boekaerts & Cascallar, 2006). It was also decided to investigate the cognitive side of student learning because we believe that in every educational context knowledge development remains a crucial part of the curriculum. While competence consists of knowledge, skills and attitudes, very little research has been conducted on the manner in which and degree to which student knowledge develops in competence-based learning environments. However, in future research it would be relevant to also pay attention to the meta-cognitive and affective aspects of learning and the relative position of these different aspects of learning as well as to meta-cognitive and affective outcomes.

In the present research, an ongoing educational innovation was investigated. The implementation of competence-based education was still underway in many of the schools which participated. As reported in Chapter 4, the majority of the PVSE schools turned out to have implemented only some of the characteristics of competence-based education (i.e., 7 out of 14 participating schools). Only two learning environments could be characterized as mainly competence-based. In a comparable study by de Bruijn et al. (2005) within the context of VET, similar results were found. Given that the implementation of competence-based education was still underway in many of the schools, the question arises whether there was sufficient variation in the participating schools. The imperfect implementation of the characteristics of competence-based education may partially explain our somewhat disappointing results and effect sizes (van Amelsvoort, 1999; Bergen & van Veen, 2004; Oemar Said, 2009). In future studies, greater attention should perhaps be paid to (the monitoring of) the implementation process of the various characteristics of competence-based education, the type of student guidance provided by the teachers and the possible influences of these factors on the results of the studies. Follow-up data collection after a period of few years could provide insight into the occurrence of possibly different results after the PVSE schools have implemented the characteristics of competence-based learning more solidly. A larger sample of schools could improve the representativeness of the research results. The adoption of a longitudinal research design to investigate the effects of competence-based learning environments might also be relevant. In this type of study, the process of implementation for the characteristics of competence-based education and the effects of such on student learning can be followed during a number of years with different measurement moments per year. Thus, possibly the positive effects reported for the study described in Chapter 6 may also be found for more schools as they gain greater experience with competence-based education.

Questionnaires were used to investigate the preferences of students for particular goal orientations and information processing strategies. The quantitative questionnaire instruments appeared to tap approximately the same aspects of the students' goal orientations and information processing strategies as more qualitative measurement instruments. Nevertheless, questionnaires provide little insight into the motives underlying the goal orientations and information processing strategies of students. In future research, attention could therefore be paid to the learning motives of larger groups of PVSE students. Such studies are clearly of relevance as very little research has been conducted on how learning processes of PVSE students come into being.

Questionnaires are often used to investigate the *preferences* of students for particular types of learning. The preferences of students seem to be somewhat more stable than their actual learning behaviour during the performance of a learning task (van Hout-Wolters, 2009; Winne & Perry, 2000). In future research, attention should therefore be paid to not only the preferences of students but also their actual goal orientations and information processing strategies during the conduct of a learning task. More direct, task-related measures such as sorting tasks, think-aloud techniques and the tracking of eye movements while students work on learning tasks can be undertaken to gain insight into the concrete learning behaviour of students under different circumstances (van Hout-Wolters, 2009). In such a manner, perhaps greater insight can also be gained into behaviour of PVSE students regarding deep information processing strategies. Such insight is necessary because the role of deep information processing strategies in the learning of PVSE students has been found to be rather obscure up until now (see Chapter 5). That is, PVSE students appear to differ from other students in this respect.

The instruments used to investigate the preferences of PVSE students for particular goal orientations and information processing strategies were adapted for use within the context of PVSE. The goal orientations questionnaire was found to be both reliable and valid; it was also previously tested within the context of PVSE. The information processing strategies questionnaire was adapted for use within the context of PVSE specifically in the present research. As we found somewhat different results than in other studies conducted using comparable instruments, further research is needed. Attention should be paid to optimization of the questionnaire's construct validity in particular.

The method of concept mapping was used to gain insight into the elaborateness and organization of the students' knowledge regarding a core concept in competence-based PVSE. Concept mapping appeared to be a suitable means to investigate the structure and development of student knowledge. Various criteria derived from previous studies employing concept maps were combined to analyze our concept maps: the number of nodes and links, the relevance and relative importance of the concepts in the maps, the types of connections between concepts, the depth of the maps (i.e., number of layers) and the general content of the maps (i.e., clusters of concepts). The findings were combined to create a Likert-scale score for the quality and development of the student's knowledge, which allowed us to create a more parsimonious structural model (see Chapter 5). In future research, the concept maps of students might be considered per element (e.g., number of nodes, types of connections) leading to greater insight might be gained into the development of specific characteristics of student knowledge.

In the present research, characteristics of competence-based learning environments were investigated via teacher perceptions of the learning environments they created. In learning environments research, student perceptions are typically analyzed because student perceptions are assumed to be more similar to the observations and judgements of experts (i.e., researchers or external observers) than teacher perceptions. It is also shown that student perceptions — as opposed to, for example, teacher perceptions — can explain a relatively larger amount of the variance in student outcomes (Fraser, 1998). In the present research, it was decided to examine teacher perceptions of the learning environments they created as relatively new learning environments were being investigated. It was expected that students would not be very capable of judging a situation to which they were not as yet accustomed. In future research, students' perceptions of the competence-based learning environments they are in should also be investigated — that is, once they have become accustomed to working in a competence-based learning environment.

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**Appendix A:** Instruction for drawing a concept map; as provided to the participating student

This instruction should be provided to the students by a teacher before they will start constructing concept maps individually. It is important that every subject that is mentioned here is explained to the students. Providing this instruction takes about 5-10 minutes.

- The purpose of making a concept map is: mapping everything you know about … (core concept).
- Why? We are investigating how students develop knowledge in PVSE.
- What is a concept map? It looks like a "wordspider"(in Dutch: woordspin) but is a little more complicated (the legs of the spider can be connected to each other, more spiders can be connected to each other, it could become a kind of spaghetti or network).
  NB: If students are not familiar with "wordspiders", a sample could be drawn on the blackboard.
- Exercise: Construct a concept map about "weather" on the blackboard with all students in order that they see what the intention is. Let the students mention concepts and make associations. Draw the concept map on the blackboard immediately (duration: a few minutes).
- How do you make a concept map?

  1. **Make a list of concepts:**
     - Write down all concepts that come to your mind about … (core concept).
     - Write down between 20 and 40 concepts.
     - If you have an idea, ask yourself questions: Why? How? What? Where? Who? When? When you do so, you will probably get new ideas.
     - Read your list of concepts and think about which concepts are related.
     - Underline about 3 to 5 concepts that are, according to you, most important.
  2. **Put the concepts in the concept map:**
     - In the middle of the concept map you see … (core concept)
     - Around … (core concept) other concepts that are related to … (core concept) should be filled out.
     - Concepts that belong to each other should be put near each other.
     - The most important concepts should be close to the centre, the less important concepts should be more to the outside (you can use the circles on the paper as an aid to do so).
  3. **Make connections:**
     - Link the concepts that are related to each other by means of lines or arrows.
     - Put a short explanation next to the links, in which you describe the relation between the two concepts that you connected to each other.

**Appendix B:** Observation scheme: characteristics of the learning environment and type of guidance (based on de Bruijn et al., 2005)

| | Variable | Description |
|---|---|---|
| | *Characteristics of the learning environment* | |
| C1 | Emphasis on functional and authentic learning | - Teacher has students work on real tasks<br>- Teacher has students work for real companies<br>- Teacher creates connected parts of learning content (no fragmentation) |
| C2 | Curriculum arranged around situations and actions occurring in professional practice | - Teacher creates tasks which occur in working practice<br>- Teacher avoids separation of subject-related theory and general skills<br>- Teacher pays little attention to training of (separate) instrumental skills |
| C3 | Explicit attention to the development of learning skills and problem solving | - Teacher indicates how the task can be done and/or helps students discover this<br>- Teacher guides students in solution of problems |
| C4 | Zooming from complex working situations to underlying (partial) skills and knowledge | - Teacher lets students work on the basis of a whole-task learning model (from core concept to underlying knowledge, skills and attitudes to tasks)<br>- Teacher promotes more than just linear construction of knowledge and skills |
| C5 | School monitors the coverage of competences during the learning process | - Teacher takes target competences and partial knowledge, skills and attitudes as starting point<br>- Teacher operationalizes competences (into levels or indicators)<br>- Teacher does not pay attention to only knowledge and skills which are easily assessed |
| C6 | Students frequently use many different sources of information, teaching aids and places to work | - Teacher provides different sources of information and sees that students use these<br>- Teacher provides different types of work places and sees that students use these |
| C7 | Much interaction between students which stimulates them to learn from each other | - Teacher has students collaborate<br>- Teacher has students consult with each other<br>- Teacher sees that students must depend upon each other for the conduct of tasks |
| C8 | For many assignments, input from fellow students is crucial | - Teacher sees that students must depend upon each other for the conduct of tasks |
| C9 | A mix of teaching methods is used | - Teacher has students work in a whole-class manner, in groups and also individually using different procedures |
| C10 | Students acquire knowledge and skills by working in an active and exploratory manner | - Teacher creates opportunities for students to explore<br>- Teacher sees that students are active<br>- Teacher is aware of what knowledge and skills students can develop working in an active and exploratory manner |

| | Variable | Description |
|---|---|---|
| | *Characteristics of the learning environment* | |
| C11 | The most important teaching activity is to stimulate students to think up solutions on their own | - Teacher sees that students can work increasingly more independently<br>- Teacher sees that learning environment is student-centred<br>- Teacher lets students think up solutions on their own (rather than instruct) |
| C12 | An emphasis on reflective learning in which students always examine why something goes right or not | - Teacher sees that reflection regularly occurs<br>- Teacher plays an active role in making students aware of their strengths and weaknesses and how to improve these |
| C13 | Students' portfolios play an important role in assessment | - Teacher regularly has students bring portfolios up to date<br>- Teacher helps students with their portfolios<br>- Teacher monitors the quality of the portfolios together with the students<br>- Teacher assesses the quality of students also on the basis of their portfolios (using clear criteria)<br>- Teacher discusses portfolios with the students and thereby helps them with their development |
| C14 | A fixed programme order | - Teacher has students work according to fixed steps<br>- Teacher sees that there is a logical structure in the different elements of the project |
| C15 | Systematic construction of skills | - Teacher provides relevant skills training<br>- Teacher sees that skills are developed which connect to the rest of the project<br>- Teacher first provides students with tools before they have to perform complex tasks |
| | *Types of guidance* | |
| G1 | Instruction | - Delivery of information: explanation, instruction and informing |
| G2 | Demonstration | - Shows students how to do something |
| G3 | Thinking aloud | - Thinks aloud in order to provide insight into the thinking processes and problem-solving strategies of experts |
| G4 | Allowing autonomous student work | - Leaves the manner of task conduct up to the students |
| G5 | Provision of active support | - Provides additional steps and/or aids as necessary for students (scaffolding) |
| G6 | Coaching | - Guides students with respect to learning process |
| G7 | Provision of help when necessary | - Provides help when students ask for it |
| G8 | Evaluation | - Provides insight into the quality of the learning result |
| G9 | Feedback | - Provides insight into the quality of the learning process |

## Summary

### Students' goal orientations, information processing strategies and knowledge development in competence-based pre-vocational secondary education

*Problem definition*

During the last decade, many schools in Dutch Pre-Vocational Secondary Education (PVSE) have taken the initiative to implement forms of competence-based education. Competence-based education starts from several assumptions. First, competence-based education generally strives to create learning environments in which students must work on complex and challenging learning tasks and thereby develop essential problem-solving and collaborative learning skills. Second, the manner in which the active construction and integration of knowledge, skills and attitudes is guided in competence-based education appears to be of vital importance. Third, in competence-based education students are stimulated to integrate knowledge, skills and attitudes and thereby develop numerous competencies. However, these assumptions have hardly been put to the test and little empirical information is available with regard to students' learning processes in competence-based PVSE.

With regard to competence-based PVSE, three aspects of student learning are expected to be of particular relevance. First, the goal orientations of students are an important engine in the learning process and are the result of either intrinsic or extrinsic motives. Goal orientations reflect the type of goals students prefer to pursue and determine the effort a person is willing to put into learning. Second, the goal orientations of students can be expected to influence the cognitive learning strategies or information processing strategies used by students. Information processing strategies refer to the processing of information for the attainment of students' learning goals and can be distinguished into deep and surface processing strategies. Third, the types of information processing strategies used by students can influence, in turn, the quality of certain learning outcomes. With respect to learning outcomes, this research focused on the development of knowledge.

In this dissertation the associations between student learning processes – in terms of goal orientations, information processing strategies and knowledge development – and the extent to which characteristics of competence-based education have been implemented into PVSE schools were described and explored. The general research question was: *What are the relations between the goal orientations, information processing strategies and knowledge development of students in competence-based PVSE?* This general research question was divided in the following, more specific research questions:

(a) Which instruments appear to be most suitable to investigate the goal orientations, information processing strategies and development of knowledge of students in competence-based PVSE?
(b) What structural relations exist between the goal orientations, information processing strategies and development of knowledge of students in competence-based PVSE?
(c) What is the relation between the development of PVSE students' knowledge and the characteristics of competence-based learning environments?
(d) Which characteristics of the learning environment and which knowledge and behaviours of teachers regarding student guidance promote students' learning processes and development of knowledge?

The research described in this dissertation aimed to contribute to the building of theory with respect to student learning within a PVSE context.

*Instruments for the investigation of goal orientations, information processing strategies and development of knowledge*

In *Chapter 2*, different instruments for the measurement of the goal orientations of students in PVSE were compared. The psychometric properties of three instruments which can be used to identify the preferences of students for mastery, performance or work-avoidance orientations to learning were explored. This was done using a semi-structured interview, a questionnaire and a sorting task.

The goal preferences of each student on the different instruments were compared, and a conclusion was drawn with regard to each student's *general* goal orientation (i.e., the most frequently occurring goal orientation across the three instruments). More importantly, the most suitable instrument to assess the goal orientations of PVSE students could be determined. That is, the instrument showing the most conclusions similar to the general orientations of the individual students, but also displaying high reliability and high construct validity, was judged to be most suitable. The questionnaire proved most accurate. The questionnaire produced the smallest number of discrepant goal orientations when compared to the general goal orientations of the individual students. In addition, the reliability of the questionnaire was found to be sufficient. The interview provided relevant supplementary information on the goals of the students and underlying motives. The questionnaire and interview results appeared to correspond best to the general goal orientations of the students. The sorting task appeared to be less suitable. Given the more sound psychometric properties of the instrument *and* the practical advantages (i.e., efficiency) of such, it was decided that the questionnaire would be the best instrument for investigating the goal orientations of students in PVSE.

In *Chapter 3*, a comparison of different instruments which can be used to identify the information processing strategies of PVSE students in a study comparable to the preceding study was described. The psychometric properties of three instruments used to identify the preferences of PVSE students for the use of deep or surface information processing strategies were explored. This was done using a semi-structured interview, a questionnaire and the think-aloud method.

A conclusion regarding the *general preference* of a student for a particular information processing strategy or combination of strategies was determined (i.e., the most frequently preferred information processing strategies based on the three instruments). More importantly, the most suitable instrument to assess the information processing strategies of PVSE students could be determined. Significant correlations were found between the results for the three instruments, which suggested that the three instruments measured largely the same aspects of the information processing preferences of students. The questionnaire appeared to be the most accurate instrument and allowed easy classification of students according to their information processing preferences. The scales of the questionnaire showed sufficient reliability. The think-aloud method provided rich and direct insight into the information processing strategies preferred by students for a particular learning task and the frequencies with which these strategies were used. The interview results largely corresponded to the results produced by the other instruments, but the interview data lacked the expected richness and depth. Given the accuracy and ease of the questionnaire for the classification of students with regard to their information processing preferences, it was decided that the questionnaire instrument would be the best instrument for investigating the information processing strategies of students in PVSE.

In *Chapter 4*, a method to investigate the knowledge development of students in terms of elaborateness and organization was chosen. In order to answer the general research question, the knowledge development of students had to be investigated across subjects, PVSE sectors and schools. Based upon a review of the relevant research literature, it was decided to adopt the so-called concept mapping technique to investigate the knowledge development of PVSE students. Concept maps are composed of knowledge in the form of concepts and the relations/links between these concepts. Within the context of the present research, concept maps were collected from students prior to their participation in a learning project and after completion of the project. This allowed comparison of the concept maps with regard to a core concept from the relevant project at pretest and posttest and thus provided direct insight into the students' knowledge development. In the analyses of the concept maps, attention was paid to the number of nodes and links, the relevance and relative importance of the concepts included in the maps, the types of connections drawn between the concepts, the depth of the maps (i.e., number of layers) and the general content of the maps (i.e., clusters of concepts). These features provided information on the quality of the students' knowledge with regard to a particular topic over time and were well-suited to investigate the knowledge development of students in PVSE.

Given that different PVSE learning environments were examined in this research project, it was necessary to investigate characteristics of these environments. With such information, it was possible to investigate the relations between characteristics of the learning environments and students' knowledge development (see *Chapter 4*). In order to characterize learning environments and classify them in terms of the extent to which they are competence-based, it was decided to use a questionnaire originally developed by de Bruijn et al. (2005). In the present research, the characteristics of the competence-based learning environments were operationalized using a *content* dimension and a *guidance* dimension. The content dimension concerned the manner in which learning content was dealt with in the relevant learning environment; the guidance dimension concerned the different types of student guidance provided by teachers, such as coaching and providing feedback. Based on the reliability and validity of the questionnaire, it was concluded that the teacher questionnaire was suitable to investigate the characteristics of competence-based learning environments.

*Structural relations between goal orientations, information processing strategies and development of knowledge*

In *Chapter 5*, a study of the goal orientations, information processing strategies and knowledge development of PVSE students in 14 schools was described. The purpose of this study was to investigate the relations between these aspects of student learning within the context of PVSE. The preferences of the students for specific types of goal orientations and information processing strategies were investigated via the administration of questionnaires. Their knowledge development was charted via comparison of the concept maps created by them before and after participation in a learning project at the school.

The structural model tested showed the student preferences for mastery and also performance goals to contribute to their preferences for deep and surface information processing strategies. A preference for work-avoidance goals negatively affected the students' preferences for deep and surface information processing strategies. Remarkably, a performance goal orientation exerted a direct positive effect upon the quality of the students' posttest concept maps. A preference for surface information processing strategies was found to negatively influence the development of students' knowledge. Preferences for deep information processing strategies did not affect the students' knowledge development. However, students' preferences for deep and surface information processing were also found to correlate: The greater the preference for surface processing strategies, the greater the preference for deep processing strategies as well. In addition, the quality of the pretest concept maps was found to positively influence the quality of the posttest concept maps, which suggested that the students' level of prior knowledge affected their later level of knowledge. Taken together, these findings showed the relations between the goal orientations, information processing strategies and knowledge development of students in competence-based PVSE to be complex; not only direct relations but also indirect relations were found.

*Relations between the development of knowledge and characteristics of the competence-based learning environments*

The purpose of the study described in *Chapter 4* was to determine the degree to which the development of student knowledge in PVSE schools which varied with regard to the extent to which their schools had implemented characteristics of competence-based education. The implementation of characteristics of competence-based education was assessed using a teacher questionnaire. The concept mapping technique was used to characterize the students' knowledge development. This entailed having students construct concept maps for a core concept addressed in an ongoing project on two separate occasions: prior to and after completion of the project. A comparison of these pre- and post-test concept maps then provided insight into the students' knowledge development.

The results showed those students in learning environments with *fewer* characteristics of competence-based education to develop slightly more knowledge than those in learning environments with relatively more characteristics of competence-based education. The organizational characteristics of the learning environments were found to be distinctive for the development of knowledge. That is, the characteristics of the content dimension had a negative influence on development of student knowledge. More specifically, the *type* component of the content dimension, which indicates the degree to which the organization of the learning environment could be typified as potentially powerful, appeared to negatively influence the students' knowledge development to a slight extent. However, the presence of learning environment characteristics which were considered less powerful beforehand, that is characteristics considered more *customary* (i.e., more traditional), also negatively influenced the students' knowledge development. While the guidance dimension of the learning environment did not make a significant difference for the development of the students' knowledge in general, a specific *growth* component did.

When guidance was increasingly provided during the course of the students' educational careers in a learning environment, students were found to develop more knowledge. The results of the multilevel analyses showed the classifications of the learning environments (in terms of the degree to which they could be considered competence-based) and student gender to influence the students' knowledge development. Based upon the results reported in Chapter 4, it can be concluded that competence-based education did not produce purely positive effects on the knowledge development of students in the PVSE schools investigated, which is contrary to what was expected.

*Characteristics of the learning environment and knowledge and behaviours of teachers regarding student guidance for promoting students' learning processes and knowledge development*

*Chapter 6* dealt with more qualitative insight into the manner in which the content and guidance dimensions of competence-based education were given form in a "good practice" school. More specifically, the knowledge and behaviour influencing student learning of two teachers who had implemented competence-based education with marked success were examined in-depth. Semi-structured interviews and observations were undertaken to gain insight into the teachers' conceptions of competence-based education and guidance of students, their actual behaviour and their explanations of their own behaviour. Student perceptions of the learning environment created by these teachers were also examined and described.

The teachers had implemented very similar characteristics of competence-based education. One teacher could be characterized as very enthusiastic. The other teacher could be characterized as a reciprocal teacher or, in other words, a teacher who presents counter-questions rather than answers to guide student learning. This technique appeared to deepen students' learning. The high quality of the learning processes of the students in *this* learning environment found in the quantitative studies presented in Chapter 4 and 5 might have been caused by several learning environment characteristics which are not yet common practice in PVSE. For example, students participating in the learning project had to structure and interpret information gathered from different sources, which could really only be done when using deep information processing strategies. Both teachers also played an extended coaching role in student learning and clearly provided active support. Finally, students always performed tasks which were somehow related to an authentic context, which is often assumed to stimulate the relating, structuring, concrete processing and transfer of information to different contexts. It can be concluded that a well-structured curriculum, the creation of opportunities for deep student learning and active teacher guidance contributed to the high quality learning processes of students revealed in the prior quantitative studies.

*Implications for practice, limitations and suggestions for future research*

The findings in the good practice school described provided some insights that can be used in schools that are not yet entirely successful in implementing characteristics of competence-based learning environments. With respect to the promotion of preferences for both deep and surface processing strategies, it appeared to be sensible to critically review the structure of the learning tasks and the structure of the curriculum as a whole in the less successful schools. Moreover, in many schools much profit can be gained with regard to how students can best be guided by teachers in competence-based education. The role of the teacher as a coach in student learning can certainly be improved. The results of the present research are possibly restricted, for example, by the fact that no attention was paid to meta-cognitive and affective aspects of student learning, but only to cognitive learning. Moreover, regarding goal orientations and information processing strategies students' *preferences* were investigated. Research into students' actual goal orientations and information processing strategies during the conduct of a learning task may provide additional insight into the concrete learning behaviour of students under different circumstances. In future research, the ongoing implementation of competence-based education could be monitored using a more longitudinal research design. Possibly the positive effects reported for the good practice case may also be found for more schools as they gain greater experience with competence-based education. In such research, students' perceptions of the learning environment may be worthwhile to take into account as well.

**Samenvatting**

**Doeloriëntaties, informatieverwerkingsstrategieën en kennisontwikkeling van leerlingen in competentiegericht voorbereidend middelbaar beroepsonderwijs**

*Probleemstelling*

Veel scholen in het Nederlandse voorbereidend middelbaar beroepsonderwijs (vmbo) hebben de laatste jaren initiatieven genomen om vormen van competentiegericht onderwijs in te voeren. Competentiegericht onderwijs heeft een aantal uitgangspunten. Ten eerste wordt er gestreefd naar het creëren van leeromgevingen waarin leerlingen werken aan complexe en uitdagende leertaken, waardoor ze belangrijke leervaardigheden ontwikkelen om problemen te kunnen oplossen en te kunnen samenwerken. Ten tweede is de begeleiding van de actieve constructie en integratie van kennis, vaardigheden en houdingen van groot belang. Ten derde worden leerlingen in competentiegerichte leeromgevingen aangemoedigd om kennis, vaardigheden en houdingen te integreren en op die manier competenties te ontwikkelen. Deze uitgangspunten zijn echter nauwelijks onderzocht. Er is bovendien weinig empirische informatie beschikbaar over de leerprocessen van leerlingen in competentiegericht vmbo.

Drie aspecten van het leren van leerlingen lijken van bijzonder belang te zijn, namelijk doeloriëntaties, informatieverwerkingsstrategieën en leerresultaten. De doeloriëntaties van leerlingen zijn een belangrijke motor van het leerproces. Deze doeloriëntaties vloeien voort uit intrinsieke dan wel extrinsieke motivatie. Doeloriëntaties weerspiegelen het type doelen dat leerlingen bij voorkeur nastreven en bepalen de moeite die zij willen doen om te leren. Doeloriëntaties van leerlingen oefenen vervolgens invloed uit op de informatieverwerkingsstr ategieën die leerlingen gebruiken. Deze strategieën worden gebruikt voor het verwerken van informatie zodat de leerdoelen van leerlingen bereikt worden. Er kan een onderscheid gemaakt worden tussen diepe en oppervlakkige verwerkingsstrategieën. Ten slotte kunnen de informatieverwerkingsstrateg ieën die leerlingen gebruiken weer de kwaliteit van bepaalde leerresultaten beïnvloeden. In dit onderzoek ligt de nadruk op kennisontwikkeling als leerresultaat.

In dit proefschrift worden de relaties beschreven en verkend tussen de leerprocessen van leerlingen – in termen van doeloriëntaties, informatiever werkingsstrategieën en kennisontwikkeling – en de mate waarin kenmerken van competentiegericht onderwijs geïmplementeerd zijn op vmbo-scholen. De centrale vraagstelling was: *Wat zijn de relaties tussen de doeloriëntaties, informatieverwerkingsstrategieën en kennisontwikkeling van leerlingen in* *competentiegericht vmbo?* Deze centrale vraagstelling werd onderverdeeld in de volgende, meer specifieke onderzoeksvragen:

(a) Welke instrumenten zijn het meest geschikt om de doeloriëntaties, informatieverwerkingsstrategieën en kennisontwikkeling van leerlingen in competentiegericht vmbo te onderzoeken?
(b) Welke structurele verbanden zijn er tussen de doeloriëntaties, infor matieverwerkingsstrategieën en kennisontwikkeling van leerlingen in competentiegericht vmbo?
(c) Wat is de relatie tussen de kennisontwikkeling van vmbo-leerlingen en de kenmerken van competentiegerichte leeromgevingen?
(d) Welke kenmerken van de leeromgeving en welke kennis en gedragingen van docenten met betrekking tot het begeleiden van leerlingen dragen bij aan de leerprocessen en de kennisontwikkeling van leerlingen?

Het onderzoek beoogt bij te dragen aan de theorievorming rondom het leren van leerlingen in het vmbo. Tevens levert het suggesties voor het inrichten van leeromgevingen in competentiegericht vmbo.

*Instrumenten voor het onderzoeken van doeloriëntaties, informatie-verwerkingsstrategieën en kennisontwikkeling*

In *hoofdstuk 2* worden verschillende instrumenten om de doeloriëntaties van leerlingen te onderzoeken met elkaar vergeleken. De psychometrische eigenschappen van drie instrumenten die gebruikt kunnen worden om de voorkeuren van leerlingen te bepalen voor de doeloriëntaties “mastery” (beheersen), “performance” (presteren) en “work-avoidance” (werk vermijden) worden verkend. Deze instrumenten zijn een semi-gestructureerd interview, een vragenlijst en een sorteertaak.

Met elk instrument is de voorkeur van iedere leerling voor bepaalde doelen onderzocht en vergeleken. Vervolgens is een conclusie getrokken over de *algemene* doeloriëntatie van iedere leerling: de meest voorkomende doeloriëntatie op basis van vergelijking van de resultaten van de drie instrumenten. Bovendien is het meest geschikte instrument om de doeloriëntatie van leerlingen vast te stellen bepaald. Het instrument waarbij de meeste conclusies gelijk bleken te zijn aan de algemene doeloriëntatie van de individuele leerlingen, maar waarbij ook sprake was van een hoge betrouwbaarheid en constructvaliditeit, is gekozen als het meest geschikte instrument. De vragenlijst bleek het meest accuraat te zijn. Met behulp van de vragenlijst zijn de minste afwijkende doeloriëntaties ten opzichte van de algemene doeloriëntatie van de individuele leerlingen gevonden. Daarnaast bleek de betrouwbaarheid van de vragenlijst voldoende te zijn. Het interview verschaft relevante aanvullende informatie over de doelen van leerlingen en de onderliggende motieven daarbij. De resultaten gevonden met behulp van de vragenlijst en het interview kwamen het meest overeen met de algemene doeloriëntatie van de leerlingen. De sorteertaak bleek minder geschikt te zijn. De vragenlijst is – vanwege de bevredigende psychometrische eigenschappen van het instrument én de praktische voordelen ervan (efficiency) – gekozen als het meest geschikte instrument voor het onderzoeken van de doeloriëntaties van leerlingen in het vmbo.

In *hoofdstuk 3* worden verschillende instrumenten voor het onderzoeken van de informatieverwerkingsstrategieën van leerlingen met elkaar vergeleken. Het onderzoek is vergelijkbaar met het hierboven beschreven onderzoek. De psychometrische eigenschappen van drie instrumenten die gebruikt kunnen worden om de voorkeuren van leerlingen te bepalen voor het gebruik van diepe of oppervlakkige verwerkingsstrategieën zijn verkend. Deze instrumenten zijn een semi-gestructureerd interview, een vragenlijst en de hardop-denk methode.

Een conclusie is getrokken over de *algemene voorkeur* van een leerling voor een bepaalde informatieverwerkingsstrategie of combinatie van strategieën analoog aan zoals dat bij de doeloriëntaties gebeurde. Op die manier is het meest geschikte instrument om de voorkeur van de vmbo-leerlingen voor informatieverwerkingsstrategieën vast te stellen bepaald. Significante correlaties zijn gevonden tussen de resultaten van de drie instrumenten, wat erop duidt dat de drie instrumenten in grote lijnen dezelfde aspecten van voorkeuren van leerlingen voor informatieverwerkingsstrategieën lijken te meten. De vragenlijst blijkt het meest accurate instrument te zijn en biedt bovendien mogelijkheden om leerlingen eenvoudig te classificeren op basis van hun voorkeur voor informat ieverwerkingsstrategieën. De betrouwbaarheid van de schalen van de vragenlijst bleek voldoende. De hardop-denk methode biedt een rijk en rechtstreeks inzicht in de voorkeuren van leerlingen voor informatieverwerkingsstrategieën tijdens het uitvoeren van een bepaalde leertaak en in de frequenties waarmee bepaalde strategieën worden gebruikt. De resultaten van de interviews bleken in grote lijnen overeen te komen met de resultaten van de andere instrumenten, maar de verwachte uitgebreidheid en diepte van de informatie ontbrak. Aangezien de vragenlijst accuraat en eenvoudig bleek te zijn op het gebied van het meten en classificeren van de voorkeuren van leerlingen voor bepaalde strategieën, is de vragenlijst gekozen als het meest geschikte instrument voor het onderzoeken van de informatieverwerkingsstrategieën van vmbo-leerlingen.

In *hoofdstuk 4* wordt een methode beschreven voor het meten van de kennisontwikkeling van vmbo-leerlingen in termen van uitgebreidheid en organisatie van kennis. Om een antwoord te kunnen geven op de centrale vraagstelling, moest de kennisontwikkeling van leerlingen onafhankelijk van schoolvakken, sectoren binnen het vmbo en scholen gemeten worden. Op basis van een literatuurstudie is de zogenoemde concept mapping techniek gekozen voor het onderzoeken van de kennisontwikkeling van vmbo-leerlingen. Concept maps bestaan uit kennis in de vorm van concepten en relaties of verbindingen tussen deze concepten. In dit onderzoek zijn voor en na afloop van een project waaraan de leerlingen deelnamen concept maps gemaakt door de leerlingen. Hierdoor konden de concept maps, die betrekking hadden op een kernconcept dat centraal stond in het betreffende project, uit een voor- en een nameting vergeleken worden. Op deze wijze is inzicht verkregen in de kennisontwikkeling van leerlingen. Bij de analyse van de concept maps is aandacht besteed aan het aantal begrippen en verbindingen, de relevantie en het relatieve belang van de begrippen in de concept maps, het soort verbindingen tussen de concepten, de diepte van de concept maps (het aantal lagen) en de algemene inhoud van de concept maps (de clusters van concepten). Deze kenmerken voorzagen de onderzoekers van informatie over de kwaliteit en ontwikkeling van de kennis van leerlingen over een bepaald onderwerp gedurende een bepaalde periode.

Gezien het feit dat er verschillende leeromgevingen in het vmbo in dit onderzoek zijn onderzocht, was het nodig de relatie tussen de kenmerken van deze leeromgevingen en de kennisontwikkeling van leerlingen nader te onderzoeken (zie *hoofdstuk 4*). Een vragenlijst van De Bruijn et al. (2005) is gebruikt voor het beschrijven en classificeren van de leeromgevingen op basis van de mate waarin ze beschouwd konden worden als competentiegericht. In het onderzoek zijn kenmerken van competentiegerichte leeromgevingen geoperationaliseerd met behulp van een *inhoudelijke dimensie* en een *begeleidingsdimensie*. De inhoudelijke dimensie omvat de manier waarop de leerinhoud wordt behandeld in een bepaalde leeromgeving; de begeleidingsdimensie omvat verschillende vormen van leerlingbegeleiding door docenten, zoals coachen en het geven van feedback. Op basis van de betrouwbaarheid en validiteit bleek vragenlijst voor docenten geschikt te zijn voor het onderzoeken van kenmerken van competentiegerichte leeromgevingen.

*Structurele verbanden tussen doeloriëntaties, informatieverwerkings-strategieën en kennisontwikkeling*

In *hoofdstuk 5* wordt het onderzoek naar de relaties tussen de doeloriëntaties, informatieverwerkingsstrategieën en kennisontwikkeling van vmbo-leerlingen op veertien scholen beschreven. De voorkeuren van leerlingen voor bepaalde doeloriëntaties en informatieverwerkingsstrategieën zijn onderzocht met behulp van vragenlijsten. De kennisontwikkeling van de leerlingen werd in kaart gebracht door concept maps die zij voor en na deelname aan een project maakten te vergelijken.

Het structurele model dat op basis van de analyse van de data samengesteld kon worden, toont dat de voorkeuren van leerlingen voor mastery en voor performance doelen positief bijdragen aan hun voorkeuren voor diepe en oppervlakkige verwerkingsstrategieën. Een voorkeur voor work-avoidance doelen blijkt een negatief effect te hebben op de voorkeur van de leerlingen voor diepe en oppervlakkige verwerkingsstrategieën. Opvallend is dat een performance doeloriëntatie een direct positief effect uitoefent op de kwaliteit van de concept maps van de leerlingen gemaakt tijdens de nameting. Voorkeuren voor oppervlakkige verwerkingsstrategieën blijken een negatieve invloed te hebben op de kennisontwikkeling van de leerlingen. Voorkeuren voor diepe verwerkingsstrategieën hebben echter geen effect op de kennisontwikkeling van leerlingen. Er is wel een correlatie gevonden tussen de voorkeuren van leerlingen voor diepe en oppervlakkige verwerkingsstrategieën: hoe sterker de voorkeur voor oppervlakkige verwerkingsstrategieën, hoe sterker ook de voorkeur voor diepe verwerkingsstrategieën. Bovendien bleek de kwaliteit van de concept maps gemaakt tijdens de voormeting een positieve invloed uit te oefenen op de kwaliteit van de concept maps gemaakt tijdens de nameting, hetgeen de suggestie wekt dat de voorkennis van de leerlingen hun latere kennisniveau heeft beïnvloed. Al met al laten deze bevindingen zien dat de relaties tussen de doeloriëntaties, informatieverwerkingsstrategieën en kennisontwikkeling van leerlingen in competentiegericht vmbo complex zijn; er zijn niet alleen directe maar ook indirecte relaties gevonden.

*Relaties tussen kennisontwikkeling en kenmerken van de competentiegerichte leeromgevingen*

Het doel van het onderzoek dat in *hoofdstuk 4* wordt beschreven was om de mate van kennisontwikkeling van leerlingen te bepalen in vmbo-scholen die verschilden in de mate waarin ze kenmerken van competentiegericht onderwijs hebben geïmplementeerd. Deze implementatie van kenmerken van competentiegericht onderwijs is onderzocht met behulp van een vragenlijst voor docenten. De concept mapping techniek is gebruikt om de kennisontwikkeling van leerlingen in kaart te brengen. Dit houdt in dat de leerlingen twee keren een concept map moesten maken over een kernconcept uit een project dat ze volgden, namelijk voor en na afloop van het project. Door de concept maps uit deze voor- en nameting met elkaar te vergelijken, kon inzicht worden verkregen in de kennisontwikkeling van leerlingen.

Uit de resultaten blijkt dat leerlingen in leeromgevingen met *minder* kenmerken van competentiegericht onderwijs iets meer kennis ontwikkelden dan leerlingen in leeromgevingen met relatief meer kenmerken van competentiegericht onderwijs. De kenmerken van de leeromgeving die te maken hebben met de inhoud en organisatie van het onderwijs blijken van onderscheidend belang te zijn voor kennisontwikkeling. Met andere woorden, de kenmerken gerelateerd aan de inhoudelijke dimensie lijken een negatieve invloed uit te oefenen op de kennisontwikkeling van leerlingen. Wat preciezer, de component *type* van de inhoudelijke dimensie, dat te maken heeft met de mate waarin de organisatie van de leeromgeving beschouwd kan worden als competentiegericht, lijkt een lichte negatieve invloed te hebben op de kennisontwikkeling van de leerlingen. De aanwezigheid van kenmerken die van tevoren als minder krachtig werden beschouwd, met andere woorden kenmerken van leeromgeving die meer *gewoon* (lees: traditioneel) zijn, lijkt daarentegen ook een negatieve invloed uit te oefenen op de kennisontwikkeling van leerlingen. Hoewel de begeleidingsdimensie van de leeromgeving in totaal geen statistisch significante invloed blijkt te hebben op de kennisontwikkeling van leerlingen, heeft de specifieke component *groei* dat wel. Als in toenemende mate begeleiding wordt gegeven gedurende de opleiding van de leerlingen, dan ontwikkelen leerlingen meer kennis. De resultaten van de multilevel analyses tonen aan dat de classificaties van de leeromgevingen (op basis van de mate waarin ze beschouwd kunnen worden als competentiegericht) en het geslacht van leerlingen invloed hebben op de kennisontwikkeling van leerlingen. Op basis van de resultaten die beschreven zijn in hoofdstuk 4 wordt geconcludeerd dat, in tegenstelling tot de verwachtingen, competentiegericht onderwijs geen onverdeeld positieve effecten heeft op de kennisontwikkeling van de leerlingen in de vmbo-scholen die mee hebben gedaan aan het onderzoek.

*Kenmerken van de leeromgeving en kennis en gedragingen van docenten met betrekking tot het begeleiden van leerlingen die bijdragen aan de leerprocessen en kennisontwikkeling van leerlingen*

In *hoofdstuk 6* wordt ingegaan op meer kwalitatieve inzichten in de manier waarop de bovengenoemde inhoudelijke dimensie en begeleidingsdimensie vormgegeven worden in een “good practice”. De kennis en het gedrag dat van invloed is op het leren van leerlingen van twee docenten die met aangetoond succes competentiegericht onderwijs hadden geïmplementeerd, zijn in detail bestudeerd. Semi-gestructureerde interviews en observaties zijn uitgevoerd om inzicht te krijgen in de opvattingen van de docenten over competentiegericht onderwijs en het begeleiden van leerlingen, hun feitelijke gedrag in de klas en hun eigen verklaringen voor dit gedrag. Tevens zijn de percepties van de leerlingen van beide docenten ten aanzien van de leeromgeving die de docenten hadden gecreëerd onderzocht en beschreven.

De docenten blijken in hoge mate vergelijkbare kenmerken van competentiegericht onderwijs geïmplementeerd te hebben. Eén van de docenten kan getypeerd worden als erg enthousiast. De andere docent kan getypeerd worden als een “reciprocal teacher”, ofwel een docent die bij het begeleiden van leerlingen in plaats van antwoorden te geven vooral tegenvragen stelt. Deze techniek verdiept het leren van de leerlingen vermoedelijk. Uit de observaties komt naar voren dat de leerlingen tijdens het werken aan hun project bijvoorbeeld ook zelf informatie uit verschillende bronnen moesten interpreteren en structureren; iets dat eigenlijk alleen gedaan kan worden met behulp van diepe informatieverwer kingsstrategieën. Beide docenten begeleidden daarbij op een coachende manier en gaven duidelijk actieve ondersteuning. De leerlingen moesten altijd taken uitvoeren die op een of andere manier gerelateerd zijn aan een authentieke context. Men gaat er vaak vanuit dat dit soort taken het relateren en structuren van informatie, het concreet verwerken van informatie en de transfer van informatie naar andere contexten bevorderen. Geconcludeerd wordt dat een goed gestructureerd curriculum, gecreëerde mogelijkheden voor diep leren en actieve ondersteuning door docenten een bijdrage leveren aan de kwalitatief hoogwaardige leerprocessen van de leerlingen in deze casus die aan het licht kwamen in de voorgaande kwantitatieve onderzoeken.

*Implicaties voor de praktijk, beperkingen en suggesties voor toekomstig onderzoek*

De bevindingen van het onderzoek in de “good practice” zouden voor een deel gebruikt kunnen worden door scholen die op dit moment nog niet volledig slagen in het op de juiste manier vormgeven van competentiegerichte leeromgevingen. Met betrekking tot het stimuleren van het gebruik van zowel diepe als oppervlakkige verwerkingsstrategieën lijkt het verstandig om de structuur van zowel leertaken als het curriculum als geheel eens kritisch tegen het licht te houden in de minder succesvolle scholen. Bovendien kan er op veel scholen een behoorlijke winst worden behaald met betrekking tot het begeleiden van leerlingen door docenten in competentiegericht onderwijs. Uit de resultaten van ons onderzoek blijkt dat de coachende rol van de docent zeer waarschijnlijk kan worden verbeterd op veel scholen.

De resultaten van het onderzoek dat in dit proefschrift werd beschreven, zijn (mogelijk) beperkt door bijvoorbeeld het feit dat er geen aandacht is besteed aan de meta-cognitieve en affectieve kanten van het leren van leerlingen, maar alleen aan de cognitieve kant. Bovendien zijn, met betrekking tot doeloriëntaties en informatieverwerkingsstrategieën, alleen voorkeuren van leerlingen onderzocht. Onderzoek naar de feitelijke doeloriëntaties en informatieverwerkingsstrategieën gedurende het uitvoeren van een leertaak zou aanvullende inzichten kunnen geven in het concrete leergedrag van leerlingen onder verschillende omstandigheden. In toekomstig onderzoek kan het implementatieproces van competentiegericht onderwijs onder de loep genomen worden met behulp van een meer longitudinale onderzoeksopzet. Mogelijkerwijs worden de positieve effecten die nu vooral in de "good practice" te zien zijn dan in steeds meer scholen gevonden, wanneer deze ook meer ervaring opdoen met competentiegericht onderwijs. In dit type onderzoek zou het de moeite waard zijn om ook de percepties van de leerlingen over de leeromgeving te onderzoeken.

**List of publications**

*Articles in peer-reviewed journals*

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**Curriculum vitae**

Maaike Koopman was born on 2 May 1979 in Enschede, the Netherlands. After pre-university education, she went to the Elementary School Teacher Training College in Groningen. Next, she studied educational sciences at the University of Groningen. After her graduation in 2004, she worked as a freelance educational researcher in the field of school choice. In 2005, she started as a PhD-student on learning processes of pre-vocational secondary education students at Fontys University of Applied Sciences (Fontys Pedagogisch Technische Hogeschool) and the Eindhoven University of Technology (Eindhoven School of Education). Currently, she is working as a researcher and teacher educator at the Fontys Pedagogisch Technische Hogeschool.

**Eindhoven School of Education**

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