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Conceiving the Relationship between Theory and Practice in T-VET. An in-depth Study on Key Actors’ Epistemological Perspectives.

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Note: Christiane Timmerman passed away before publication of this work was completed.

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Abstract

The integration of theory and practice constitutes an anchor of today’s technical vocational education and training (T-VET) and a major determinant of professional development. Understanding such integration is expected to contribute to pedagogical advancement and to provide new research tools. Current knowledge on the epistemological roots of pedagogical approaches is not automatically informative of the conceptions and beliefs of the students and their instructors in particular learning contexts. Therefore, if we are to disentangle further the theory-practice integration in T-VET, a first step is to grasp how these key actors conceive of theoretical and practical knowledge and the relationship between these kinds of knowledge. Thirty-eight subjects in dual T-VET in the field of chemical process technology, participated in serial and single focus groups. While adopting a grounded theory approach, the present qualitative study reveals the negotiated epistemological perspectives of students, school-instructors and workplace-instructors: forms of knowledge that respond to conceptions of theory or practice, the relationships between these forms of knowledge and the multiple agents who perform each connecting activity. The findings reveal a possible expression of the overall ‘integration of theory and practice’ as involving a network of relationships that are embodied by multiple agents. The implications are discussed.
Introduction

The close relationship between theoretical and practical knowledge has been widely recognized as a major determinant of professional development in a number of fields. This refers to the key role that has been attributed to the relationship between theory and practice in the context of professional learning (Beckett 2000; Gessler and Howe 2015), knowledge transfer in school-work transitions (Guile and Griffiths 2001; Heinz, Kühn and Witzel 2005; Raelin 1997) and expertise development as an inherent part of lifelong learning (Tynjälä 1999, 2008). Understanding this relationship is expected to advance pedagogical approaches, in addition to providing new research tools and perspectives.

In the realm of theory-practice integration, a major problem is that learners are often left either "locked into practice and cut off from theory or with the dilemma of attempting to ‘connect’ theory and practice" (Guile 2006, 252). Such is the net effect of an epistemological disagreement that has led to extreme positions, ranging from Cartesian separations of theory and practice, to dialectic syntheses, and to oversimplifications of the relationship between those kinds of knowledge (Guile 2006). Other researchers have committed to investigating epistemological perspectives on how professional or vocational knowledge is constituted and developed, by reviewing philosophical legacies throughout history (Guile 2006; Hiim 2017).

However, understanding the various epistemological roots of pedagogical approaches is not automatically informative about the conceptions and beliefs (in the psychological sense) of the micro-level actors (e.g. students and their instructors) in particular learning contexts. These actors do not necessarily experience and interpret professional knowledge through the received epistemological lenses. If we are to disentangle further the theory-practice integration in any particular domain, we propose that the first step is to grasp how key actors in such a context conceive of theoretical knowledge, practical knowledge and, most importantly, the relationship between these kinds of knowing. Accordingly, the present investigation represents an effort to uncover the various views that people hold on theoretical and practical knowledge, as well as views on how these kinds of knowing relate to each other. For this purpose, it appears very propitious to focus on the context of alternating school-based and work-based learning in technical vocational education and training (T-VET); we elaborate this argument in the methods section.

More specifically, the research questions are as follows:
(1) How do key actors in T-VET conceive of theoretical and practical knowledge?
(2) What are these actors’ views on the relationship between theoretical and practical knowledge?

In answer to these questions, this paper reports on an in-depth qualitative study focusing on a micro-level of analysis. The investigation was conducted within the context of alternating school-based and work-based learning (often referred to as dual learning), within the field of chemical process technology (CPT). Both research questions refer to perceptions and epistemological beliefs as units of analysis; in particular, our interest resides in students and instructors’ conceptions, perspectives, intersubjective interpretations and expectations about knowledge and about how knowledge is generated, validated, shared and used. Furthermore, while the first research question primarily seeks description, the second one seeks hypothesis generation (i.e. theory formation based on empirical data). It follows that a grounded theory approach to research is appropriate (Glaser 1992; Glaser and Strauss 1971; Strauss and Corbin 1998) and that, rather than relying on an a priori theoretical framework, our research efforts were informed by existing knowledge in terms of sensitising concepts (Mortelmans 2007) which we present in the following section.

This paper is further structured as follows. The next section provides a common ground for the further interpretation of our findings. In the methods section, we discuss the research design, context and procedure. In the results section, we present the empirical findings in a synthesised way. In the discussion section, we build on our findings to elaborate the answers to the research questions (along with emergent conclusions that go beyond the primary purpose of the study). In the concluding section we isolate the key message and discuss the plausible implications.

Epistemological Assumptions: From Legacies to Personal Conceptions

In this section, we briefly articulate a number of insights in order to provide a common understanding and clarify our interpretations. This paper, therefore, draws upon existing knowledge in terms of sensitising concepts (Mortelmans 2007), rather than borrowing any fixed framework. This approach is consistent with the methodology adopted (i.e. grounded theory), as later described in the methods section.

By presenting concepts and theories to which we subscribe, as recommended by the methodological literature (e.g. Gillham 2003; Mortelmans 2007), we overtly acknowledge
that our interpretations of the empirical data might be coloured, while we arm the readers with the necessary tools to understand our interpretations and to attempt their own.

First, we touch upon the epistemological roots of vocational knowledge (Guile 2006, 2010; Hiim 2017). Second, we move towards the instructional actors’ beliefs about knowledge through the topic of personal epistemologies (Billett 2009; Hofer and Pintrich 1997, 2012). Finally, we introduce the notion of forms of knowledge in terms of vertical and horizontal knowledge (Bernstein 1999; Young and Muller 2014), which is linked to the concept of a ‘zone of proximal development’ as part of the theory of cultural mediation (Vygotsky 1987).

**Epistemological Roots of Professional or Vocational Knowledge**

Several descriptions of vocational knowledge have been proposed (Barber 2012; Gessler and Howe 2015; Guile 2006; Guile and Griffiths 2001; Sappa, Choy and Aprea 2016; Tynjälä 2008); each description relies ( overtly or implicitly) on a particular perspective on vocational or professional knowledge. The study of such perspectives, which are often attempts to resolve the theory-practice dilemma, can shed light on the possible content of the ‘integration of theory and practice’.

Both Hiim (2017) and Guile (2006) have reviewed legacies of various philosophers (as well as sociologists and psychologists) and have distinguished a number of rationales, each with its own epistemological roots and each conferring a different meaning to vocational or professional knowledge. These ontological and epistemological stances shaped the understanding of the very nature of vocational knowledge, the extent to which a true interplay between forms of knowledge may occur and the learning activities proposed, if any, for the ‘acquisition’ of vocational knowledge (Guile 2006; Hiim 2017).

The perspective we adopt matters in our quest to understand how students learn theory and practice in an integrative manner. Such perspectives appear to have different powers to resolve the theory-practice duality or, in other words, they are not equally opportune to understanding integration. While dualistic views on theory and practice are not conducive to the reconciliation of these kinds of knowing (Guile 2006; Hiim 2017), neither are perspectives that tend to gloss over the theoretical component of professional knowledge (Guile 2006). In conclusion, if we are to understand how students concurrently learn and integrate theory and practice, we need to adopt a non-dualistic position that still allows us to acknowledge how theory and practice are distinct at the analytical level. Perspectives rooted in social practice and inference appear to be indicated for such a purpose (Guile 2006, 2010).
Conceiving the Relationship between Theory and Practice in T-VET

The Instructional Actors' Beliefs about Knowledge

The epistemological perspectives on professional and vocational knowledge discussed in the previous paragraphs constitute rationales that have the power to influence education at the macro, meso and micro levels. The more we approach the micro-level (seen as the everyday processes of teaching and learning), the more we expect the personal epistemologies of the actors to be determinant of the integration of theory and practice.

Personal epistemology refers to beliefs about the nature and origins of knowledge (Hofer and Pintrich 2012). Several terms are used in this regard, including epistemic beliefs (e.g. specific beliefs about the nature of knowledge and knowing), personal epistemology (e.g. a system of epistemic beliefs), and epistemic cognition (e.g. mental processes associated with knowledge) (Barger, Wormington, Huettel and Linnenbrink-Garcia 2016). In keeping with such distinctions, we also use the term ‘personal epistemology’ to refer to sets of epistemic beliefs (e.g. dogmatism). Moreover, two approaches to personal epistemologies can be distinguished, i.e. the cognitive-psychological approach, which typically focuses on the structural aspects of beliefs about knowledge (Bromme, Pieschl and Stahl 2010; Hofer and Pintrich 1997; 2012; Schommer-Aikins, Mau, Brookhart and Hutter 2000), and the sociological strand, which is concerned with the social-order aspect of knowledge conceptions (de Brabander and Rozendaal 2007).

At least two issues need to be considered when studying personal epistemologies. First, epistemic beliefs have been identified as both domain-specific and domain-general (Muis, Bendixen, and Haerle 2006). Second, it has been proposed that the role and development of personal epistemologies, when learning through work, extend beyond epistemological beliefs. Instead, personal epistemologies are regarded as active, intentional and derived from each individual’s unique set of social experiences (Billett 2009).

Overall, the concepts presented with regard to personal epistemologies informed our hypothesis that the epistemological beliefs of students play a role in their capacity to integrate theory and practice. Given that our interest in (inter)personal epistemologies is closely related to our research questions, we focus on the actors’ beliefs about the nature of theoretical and practical knowledge, as well as on their arguments to invoke knowledge validity.

Forms of Knowledge

In order to provide an initial idea of the possible nature of theory and practice and the relationship between them, we turn to other authors (e.g. Bernstein 1999; Vygotsky 1987;
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Winch 2013; Young 2003b), while we acknowledge their theoretical contributions on the differentiation between forms or kinds of knowledge. Firstly, we resort to Bernstein's (1999) distinction of ‘horizontal’ and ‘vertical’ knowledge and discourses, which Young (2003a, 2003b) has further extended and developed. More particularly, Bernstein provides a complex distinction between two kinds of theoretical knowledge according to the way that they elaborate, i.e. either 'hierarchically' by expanding a conceptual structure, or 'horizontally' by forming a new, parallel theoretical stem (Young and Muller 2014). In so doing, Bernstein takes a key position in the debates about knowledge in the sociology of professions. In these debates, however, it is important not to equate similar distinctions to each other (e.g. 'pure versus applied', and 'theory and practice') as such parallelism may be more obscuring than clarifying (Young and Muller 2014).

Secondly, we resort to Vygotsky’s postulation of how such structurally distinctive forms of knowledge may relate to each other (Guile 2010). According to this, horizontal knowledge (alluding to practical and everyday knowledge) is more segmented than structured, while vertical knowledge (alluding to theoretical knowledge) is organised according to a specific knowledge structure (Guile 2006). In other words, only theoretical concepts are located within a system of interconnected concepts (Guile 2010). Additionally, the more knowledge is structured, the more it is susceptible to transcending its context of origin. Building on the idea of structurally distinctive forms of knowledge, Vygotsky postulated their relationship in terms of everyday concepts and theoretical concepts growing towards one another (Guile 2010). Such growing to each other of structurally different forms of knowledge has been proposed to result from a learner's activity that is primarily social and that is culturally mediated. We refer to Vygotsky’s (1987) concept of a ‘zone of proximal development’ (ZPD). As Guile (2010) notes, the ZPD concept is intended to assist educators in identifying pedagogical interventions that will facilitate the learner’s development of the psychological functions that must be in place in order to sustain the next stage of development. This implies that there are situations in which learners have the opportunity to engage with a more competent person around a task (thus requiring reasoning with theoretical concepts) that they would not be able to perform fully on their own.

Having presented the main sensitising concepts that inform our study, we proceed to the empirical part, i.e. the research design in the methods section, the proper results and their interpretation.
Methods
We start this section with a rationale for the selection of methods. We then set out the characteristics of the research context and the participants. Finally, we describe our procedures for data collection and analysis.

Ontological and Epistemological Positioning
At this point, we articulate the assumptions underlying this investigation. Our first concern has been that our assumptions be consistent with each other and with the methodological choices we make, as the methodological literature recommends (e.g. Scott 2016). We will not deal here with extensive arguments in favour of one or another stance, but will confine ourselves to the observation that we adopted a realist ontology, i.e. “a commitment to the existence of a real, although not objectively knowable world” (Maxwell 2004, 247). Concurrently, we also embrace an interpretative epistemological position characterised by multifaceted accounts of ‘reality’ (Cohen, Manion, and Morrison 2011). Moreover, we take on a non-dualistic epistemology, i.e. the distinction between ‘theory’ and ‘practice’ pursues an analytical purpose only (Guile 2006). We also hold a voluntarist view on human nature (Cohen, Manion, and Morrison 2011), as we see people as initiators of their own actions, however subject to contextual influences.

Methods Selection
Our selection of methods was informed by our ontological and epistemological assumptions, and it is consistent with the research aims. Firstly, we adopted an ideographic methodological basis, that is reflected in an interest in the participants’ individual and negotiated perceptions, experiences and co-constructed meanings (Cohen et al. 2011). More specifically, individual views were important to us to the extent that they nourish the actors’ epistemological conceptions at a group level. Therefore, we selected an in-depth qualitative approach that relied on focus group discussions as the main data generation and data collection means. Secondly, in line with the explorative character of our research aims, we adopted a grounded theory approach (Glaser 1992; Glaser and Strauss 1971; Strauss and Corbin 1998) in order to advance multiple conceptualisations of the relationship between theory and practice, based on the experiences, intersubjective interpretations, meanings, perceptions and expectations of T-VET actors.
The Context

The study proceeded within the context of dual learning at the levels of post-secondary and higher education, in the field of chemical process technology (CPT). In its broadest sense, dual learning refers to alternating school-based and work-based learning according to a cognitive-apprenticeship approach. Graduates of these CPT programmes are qualified to work as process operators in various industrial manufacturing sectors.

More specifically, this instructional context consists primarily of two learning environments (i.e. the school and the workplace) with both differences and commonalities. Here, the school refers to non-compulsory formal education (one-year to three-year programme) provided by secondary schools or by tertiary institutions; the admission requires that students already have a secondary school degree. The workplace refers to an industrial site that has been approved to act as an education provider in collaboration with schools. In such a micro-context, the key actors are the students and their instructors. The students’ instructors are: school-based teachers and lecturers who regularly commute from the school to the workplace (hereafter called 'tutors'), and workplace instructors (hereafter called 'mentors').

We advocate that this institutional context is particularly suitable for our study, as dual learning calls for a decoupling of kinds of knowledge from learning environments (Sloane 2014). This means that the 'acquisition' of theoretical knowledge (or 'construction' or 'mastering', depending on the learning metaphor to which one subscribes) is not restricted to the school, such as practical knowledge is not restricted to the workplace. Additionally, the field of CPT offers particularly rich opportunities for study due to established scientific laws, continual growth in technological innovation and a long tradition in industry oriented work-based learning. To summarise, the CPT-context and its knowledge contents play a valuable instrumental role for the present investigation.

The Participants: Micro-level Actors in T-VET

Thirty-eight participants joined this investigation. More specifically, twenty-four students, six tutors and eight mentors in T-VET were involved in the qualitative data collection. The participating companies and their mentors were selected purposely; for tutors and students, the entire population was invited to participate. Participation in the investigation was voluntary, after providing formal informed consent. This study received a final positive
clearance from the University Research Ethics Committee. The numbers and main characteristics of participants are presented in Table 1.

Table 1. Participants in the empirical investigation.

<table>
<thead>
<tr>
<th>Group of actors</th>
<th>Number of participants and distinctive features</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>21 (18 to 25 years of age)</td>
<td>Students at the post-secondary level in three different schools.</td>
</tr>
<tr>
<td></td>
<td>3 (25 to 30 years of age)</td>
<td>Students at the higher education level in one tertiary school.</td>
</tr>
<tr>
<td>Tutors</td>
<td>4 tutors from four different schools.</td>
<td>Tasks: teaching (e.g. chemistry, physics, instrumentation and process control, and mechanics) and supporting students in their workplaces. Extensive teaching experience and limited or no work experience in the industry.</td>
</tr>
<tr>
<td></td>
<td>2 tutors from one tertiary school.</td>
<td>Tasks: comparable to those described above, plus lately a more coordinating role.</td>
</tr>
<tr>
<td>Mentors</td>
<td>8 mentors from four different chemical (or petrochemical) companies.</td>
<td>Tasks: everyday responsibilities in the production processes combined with the mentoring of students and starting operators. Extensive experience in production (10 to 30 years), varying experience in mentorship (2 to 20 years) and limited or no formal pedagogical training. Two participants also had coordinating roles.</td>
</tr>
</tbody>
</table>

Data Collection: Method and Procedure

Focus groups discussions were selected as a data collection technique, given our interest in the intersubjective perceptions and experiences of the participants, and given our expectation that the negotiation process amongst participants would yield much rich data. Eventually, one focus group discussion with tutors had to be split into two individual interviews due to practical constraints. The most important aspects of the data collection are summarised below in Table 2.
Table 2. Overview of the data collection techniques as applied.

<table>
<thead>
<tr>
<th>Singel sessions</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>5 focus groups, N = 4 to 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tutors in HE</td>
<td>2 one-to-one interviews</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Serial (recurrrent) focus group discussions</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tutors (post secondary)</td>
<td>Session 1</td>
<td>Session 2</td>
<td>Session 3</td>
</tr>
<tr>
<td></td>
<td>N = 3</td>
<td>N = 4</td>
<td>N = 3</td>
</tr>
<tr>
<td>Mentors</td>
<td>Session 1</td>
<td>Session 2</td>
<td>Session 3</td>
</tr>
<tr>
<td></td>
<td>N = 5</td>
<td>N = 5</td>
<td>N = 5</td>
</tr>
</tbody>
</table>

The focus groups were organised according to the actors' roles, i.e. five groups of students, one group of mentors and two groups of tutors. Except for the conducted with students, all focus group discussions were organised in a series of three sessions, with the same (or nearly the same) participants. Each session had its own purpose. More specifically, the first session focused on exploration, the second on in-depth discussion and the third on elaboration and exemplification. Furthermore, the participants engaged in short consultations and assignments between the sessions. Overall, this serial approach made it possible to screen the obtained data between the sessions and to adjust the schedules as needed for the following session. All of the focus groups (90 minutes each) were audio-recorded and transcribed verbatim for further analysis. The alternating phases of data collection and preliminary analysis eventually allowed us to estimate that data saturation had been achieved for the purpose of the inductive analysis.

All participants were asked in the same way about their conceptions on theory and practice and how they relate to each other. We provoked discussions with some statements on which the participants had to comment, for example: "Theories are self-explanatory", "Practice serves to validate theories", "One can integrate theory into practice but not practice into theory" and "Theory and practice are two sides of the same coin". Each time the participants were asked to provide a particular example to support their position. In the case of successive sessions, the questions were diversified for each category of participant, as each session built on the previous one. More details about the data collection process for serial sessions are given in Table 4 (Appendix A).

We stress once more that our interest throughout this study was at the group level; this is in line with the use of focus group discussions, which accounted for 96% of the data, while
only two interviews were conducted. Consequently, we can only make claims at the group level (as opposed to claims about individual conceptions).

**Data Analysis**

The transcriptions were analysed using qualitative analysis software. We sought patterns in the data according to the constant comparison method (Mortelmans 2007). More specifically, we used the principles of ‘thematising meanings’ (Braun and Clarke 2006) as a tool within the grounded theory method (Glaser 1992; Glaser and Strauss 1971; Strauss and Corbin 1998).

Following successive open and axial coding phases, we incorporated the data gradually, in order to render the themes progressively richer and more accurate. Next, we proceeded with the selective coding assisted by visualisations (Miles and Huberman 1994), as well as memos and annotations (Mortelmans 2011). We kept records of the coding steps taken throughout this analytical process, including the decision criteria for creating, merging, re-labelling or abandoning categories. The coding was performed by the first author and then all categories were discussed with the second author in order to resolve any doubtful instances by mutual agreement.

The design and analysis of the study are inevitably informed by the researchers' personal epistemology, as is always the case. Some strategies to reduce the risk of bias include: the articulation of sensitising concepts and acknowledgement of preferences (Gillham 2003; Mortelmans 2007), as well as the application of tools for "integrity against preferences" (Gillham 2003, 28-36), e.g. looking for discrepant data, discussions among the authors about the progress and result of the data analysis (peer consultation), or checking interpretations, ideas and explanations with the participants (member check).

**Results**

Our findings are organised in two parts. We address the first research question by providing an inventory of various forms of theoretical and practical knowledge. Next, we attend to the second research question by mapping the interrelationships between these forms of knowledge. Although this section presents the research findings in a synthesised fashion, those who are interested in more detailed findings can refer to Tables 5, 6 and 7 in Appendix B.
Various Forms of Theoretical and Practical Knowledge

Taken together, the accounts of all the actors suggest that there is more than simply ‘theory’ and ‘practice’ as two unique forms of knowledge that need to be integrated. People use several criteria or dimensions to classify pieces of knowledge into forms of ‘theory’ or ‘practice’. Such dimensions include (a) the physical location of the learning environment, (b) the timing and purpose of the learning, (c) the perceived applicability and (d) the extent to which a piece of knowledge can be visualised.

Physical location of the learning environment:

*To me, practice is everything except what you get in the classroom...you could put it that way.* [S3-FGD]

Timing of learning and purpose:

*There’s a small sheet about how to operate the machine that processes the samples. You can see that sheet as theory, because you have to read it and understand it. But to me it’s practice, because you read it while you’re following the steps.* [S3-FGD]

Perceived applicability:

*[…] and later, you try to do it [processing a sample] without the instructions, but you still have the instructions in case you get lost. So, for me, the instructions belong to practice, because you use them as an aid for doing practical things.* [S3-FGD]

Extent of visualisation:

*You get the theory there [instruction in the workplace]...and you see it in practice, because you’re there and they give you the theory of how it works, but you see it all happening before your eyes. But when you get the theory in the classroom, you have no image.* [S5-FGD]

Such criteria nevertheless do not provide tight, mutual exclusive categories. Subjectivity in categorising forms of knowing often occur when the same piece of knowledge is classified differently, depending on the dimension that happens to be given more consideration, or even depending on a comparison to a second piece of knowledge. Furthermore, while some people classify pieces of knowledge only on demand (i.e. when prompted), others seem to have reflected on the classification before. Moreover, in several instances no forms of knowledge can be distinguished, because they are entangled or because they are merely aspects of a larger whole. At the opposite extreme, many more instances can
be found of fragmentation. Overall, the complex relationship between the various forms of knowledge cannot always be easily disentangled.

The individual recounts and group negotiations indicate what each group of actors counted as theoretical knowledge and as practical knowledge. In the different actors' discourses, we distinguished various forms of knowledge in terms of 'theory' (i.e. pure, situated, self-constructed, and implicit) and various forms in terms of 'practice' (i.e. observational, functional, and cunning). Each category label synthesises the actors' descriptions.

The Relationships between Forms of Knowledge

The relationships between and within forms of theoretical and practical knowledge concern activities that are often carried out by multiple agents and that relate forms of knowledge to each other. Amongst the most prevalent relationships we found: application, conversion, explanation, giving meaning, interpretation, putting into perspective, representation, understanding (in terms of the resolution of inconsistencies) and validation. In most cases, the relationship is unidirectional (with the exception of interpretation). Table 7 (Appendix B) provides details about each relationship. At this point, we highlight some peculiarities that emerged during the categorisation into activities.

The aforementioned multiplicity of agents is visible in several activities. For instance, according to the mentors, the major part of pure theory is converted into situated theory by engineering suppliers and in-house engineers, so that only a small part of the conversion is done by the students and the operators in general. Furthermore, students have limited opportunities to apply forms of knowledge actively and independently in certain learning environments. Unlike what is expected in the simulated environment (where students solve problems by applying forms of theory and by being inventive), students are not expected to actually apply their knowledge by themselves in the workplace (as they only participate peripherally in the activities of others). In other words, the functional practice of students consists mainly of if-then scenarios, and their decision-making and actions are only hypothetical. This is in line with students' virtual lack of references to application.

Explanation is a frequently highlighted activity by all groups of actors. For the mentors, for example, the relationship between situated theory and both observational and functional practice is that of understanding, in the sense of being able to explain and identify plausible cause-and-effect relationships. In other words, in using situated theory to help them explain their observations, students develop practical knowledge that is grounded and that
triggers further reasoning. Moreover, the actors claim that several forms of theory make it possible to understand ‘observational practice’ through the use of arguments that are needed to give reasons: this represents a clear connection between explanation and understanding.

Interpretation, which stands out as a backward relationship with which to question and revise prior knowledge, and putting things into perspective are both activities that relate forms of knowledge to ‘external factors’ such as feedback from the manufacturing process, weather conditions or economic considerations. Indeed, it is only when there is interaction with the chemical process that the responses of the process compel interpretation through situated theory and/or observational practice. However, this relationship advanced by the mentors, applies to students only through social learning with the full operators. In its turn, putting forms of theory into perspective through comparison with e.g. observational practice, is claimed to help students understand the limitations of theory. Indeed, students learn to put theory into perspective whenever there is an apparent mismatch between their observations and what they would have expected. Such perspective is often revealed when ‘external factors’ are engaged in the explanations, i.e. site-specific factors or in situ considerations that do not pertain to general process technology. Moreover, there was a high level of agreement amongst all the actors that practice provides the factors for which theory fails to account (e.g. the production of certain by-products in a chemical reactor). Although the student is the agent carrying out this change of perspective, doing so appears as a challenging step that does not occur spontaneously and that requires the assistance of the mentor and colleagues.

Students often referred to learning various forms of knowledge, as a phased process of which a deepening activity is part. While the actors usually claimed that ‘theory comes first’, they also referred to instances in which one first observes in practice (e.g. when learning the basics of equipment working principles), and subsequently refers to the theory in order to ‘deepen’ that understanding. As did the tutors and mentors, the students referred to the relationship between various forms of knowledge as ‘understanding’, however, the concept of ‘understanding’ was used ambiguously; the actors hold different conceptions of what it means to understand something. We found at least four conceptions amongst the students alone. First, ‘understanding’ was seen as resolving an inconsistency or a contradiction. Second, ‘understanding’ something was considered as the ability to form an image of that thing; here we can attempt to picture some representation of what we are trying to understand or, alternatively, when we actually see it. Third, students regarded ‘understanding’ as an ability to provide explanations. Finally, some students conceived of ‘understanding’ as spontaneously getting used to something simply by doing it repeatedly. This last view did
not result in a relationship, as the students largely failed to advance what one learns ‘by
doing’ as a form of knowledge.

Finally, the meaning of knowledge emerged as a source of interest and motivation
amongst students. Some of them considered pure theory meaningless and argued that
observational practice assists in *giving meaning* to relatively abstract forms of knowledge that
are based on numbers, magnitudes and symbols. Similarly, *validation* was regarded not only
as finding empirical evidence for theories in observational practice, but also as confirmation
that theoretically described phenomena ‘actually exist’ and 'make sense'. In some cases,
however, students were not interested in any validation or reported that they did not dare to
question the explanations that they received. In such situations, students simply accept the
truth of knowledge by appealing to the mentor’s authority.

Table 3 synthesises the mentors, tutors and students’ perspective by mapping the
recognised forms of knowledge, as well as the ways in which such forms relate to each other.
This table should be read as follows: a form of knowledge on a row is linked to a form of
knowledge on a column by the activity given in the intersection of these row and column.
The row-to-column direction is important, as it reflects the unidirectionality as part of our
findings. In addition, the agent is noted alongside each relationship, in order to indicate who
takes each connecting action. In doing so, we borrow Vygotsky’s notion of a ‘zone of
proximal development’ (ZPD) to indicate that the student is the agent when guided by a more
knowledgeable person (e.g. the tutor, the mentor or a more experienced colleague). In Table
3, pure theory and applied general theory are connected through explanations, that a student
can only give with the assistance of their instructor.
Table 3. Map of integrating activities.
(a) By multiple agents together, i.e. the student accompanied by an instructor, (b) By the student, (c) By operators, (d) By engineers.

<table>
<thead>
<tr>
<th>pure theory</th>
<th>applied theory</th>
<th>situated theory</th>
<th>self-constructed theory</th>
<th>implicit theory</th>
<th>observational practice</th>
<th>functional practice</th>
<th>cunning practice</th>
<th>chemical process</th>
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<tr>
<td>pure theory</td>
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<td></td>
<td>explanation (a)</td>
<td>application (b)</td>
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<td>applied theory</td>
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<td>conversion (d)</td>
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<tr>
<td>situated theory</td>
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<td></td>
<td>resolving inconsistencies (b)</td>
<td>explanation (a)</td>
<td>application (a)</td>
<td>interpretation (a)</td>
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<td></td>
<td>explanation (a)</td>
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<td>application (c), explanation (a)</td>
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<td></td>
<td>broadening (a), deepening (b), giving meaning (b), recalling (b), representation (a), putting things into perspective (a), validation (a)</td>
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<td>recalling (b), representation (a), putting things into perspective (a), validation (a), representation (a)</td>
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<td>application (a)</td>
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<td>chemical process</td>
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<td>getting used (b), interpretation (a)</td>
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Conceiving the Relationship between Theory and Practice in T-VET

Discussion

As explained in the introductory section of this paper, our focus has been on the perspectives of key actors in dual T-VET concerning the nature of theoretical and practical knowing. This, we argue, is a necessary first step that allows us to interpret more fully and more correctly the underlying conceptions that account for the discourses and behaviour of these actors. Accordingly, we aimed to uncover the various views that people hold on theoretical and practical knowledge (Research Question 1), as well as their views on how these forms of knowing relate to each other (Research Question 2).

With respect to the first research question, our findings indicate that there is no such thing as ‘theory’ and ‘practice’. Instead, we identified eight forms of knowledge. Of these forms of knowledge, five were acknowledged as ‘theoretical’ (i.e. pure, applied, situated, self-constructed and implicit), with the other three forms being identified as ‘practical’ (i.e. observational, functional and cunning). The distinction between the two broad categories, as well as the distinction between the sub-categories, responded to a number of criteria that the actors employed for the purposes of classification and labelling. However, not all actors acknowledged the same forms of knowledge. The forms acknowledged by each group of actors are presented in a unified map (see Table 3). From these findings we learnt that what counts as theory and as practice is not only individual but, moreover, relative to the point of comparison and highly unstable (or even volatile). Although this last statement could be taken to show just the fragility of common sense, we contend that there is an alternative interpretation: the actors hold sophisticated epistemologies rather than dualistic or naïve ones, albeit in varying ways and to varying extents. Our interpretation is consistent with the ontological stance that theory and practice are not intrinsically different (but only different at an analytical level).

Whether a piece of knowledge is categorised as either theoretical or practical does indeed appear to stem from personal and negotiated beliefs pertaining to such aspects as (a) ways in which particular forms of knowledge are related to the features of particular learning environments (e.g. theory-formality or practice-informality); (b) the timing and purpose of learning; and (c) the perceived applicability of knowledge. These criteria are partly in line with functional and structural facets of epistemological beliefs (de Brabander and Rozendaal 2007; Hofer and Pintrich 1997, 2012), although they also include concerns relating to the microgenesis of knowledge. Furthermore, a piece of knowledge is not always categorised in
absolute terms, but rather in relation to a second piece of knowledge (whether the comparison is conscious or not).

At this point, we risk falling into an epistemological position that overlooks the need to distinguish theoretical knowledge from practical knowledge. Although our findings mainly reveal that theory and practice somehow represent a unity, and reveal how reasoning in theoretical and in practical ways are closely connected to one another, this does not mean that theory and practice are equivalent forms of knowledge (i.e. directly corresponding to each other). In Vygotsky’s (1987) terms, a ‘unity of process’ does not imply a ‘unity of identity’. While our findings do not go so far to show differences in the internal structure of forms of knowledge (Young 2003a) or in their logical structure (Beckett 2000), they suggest differences in outcomes that result from specific activities in which students and professionals engage.

Even with the limitations to provide fuller evidence of the specifics of theory and practice, we adopt the position that "we do not have to abandon this distinction because it does not reflect a dualism”’ (Guile 2006, 256). Abandoning this distinction often results in downplaying the theoretical component of vocational knowledge, with detrimental consequences for the broader perspectives of students (Guile 2006). Despite its limitations, we contend that the categorisation into sub-forms of theoretical and practical knowledge advanced in this study is legitimate. As explained before, the categorisation is the result of a systematic analysis according to the constant comparison method and it is grounded in the intersubjective views of key actors. The identified sub-forms of theory and practice allow us to see the multiple relationships that, together, reveal a possible expression of the overall ‘integration of theory and practice’. Rather than a single connection between two objects, the integration of theory and practice indeed emerges as a complex network of relationships between multiple sub-forms of knowledge (or, more correctly, multiple uses of knowledge).

The second research question pertains to relationships between and within forms of theoretical and practical knowledge. The actors’ map (Table 3) provides an answer to this question by depicting several activities that relate forms of knowledge. We identified eleven relationships among which ‘explanation’ appears as a frequently recurring relationship amongst various instances of theory and practice. Moreover, the reasoning involved in explanations is seen as a predominantly social activity.

In all cases, the relationships concern activities that are often carried out by multiple agents. Indeed, students rarely relate forms of knowledge in isolation. Instead, the relationship seems to be feasible only with the guidance of a more knowledgeable person. To
account for this mediation, we resorted to Vygotsky’s (1987) concept of a ‘zone of proximal development’. Moreover, a few relationships seem to be out of reach for the students, and even for more experienced professionals. In other words, certain linking activities are necessarily performed by others who do have full access to particular forms of knowledge. This finding imposes limits on the notion of agency (Billett 2002, 2009), which emphasises the individuals’ engagement to learn (in an integrated manner) from workplace experiences. Intentional and purposive participation for learning could thus be determined by the affordances of the workplace to an extent that exceeds our initial expectations. It also follows that the integration of theory and practice as a whole is inevitably collaborative, as the pieces of knowledge that one could integrate are distributed amongst multiple agents.

Finally, the findings suggest that mentors (as experienced operators) are not very critical of work instructions and procedures (or they are not expected to be so) and that they tend to disengage from basic theory. If extrapolated to the students (or operators-to-be), this perception of the process operator’s profession can have adverse effects on the overall integrative learning of theory and practice in T-VET.

The results of this investigation can also be seen in relation to existing knowledge. Several authors, to whom we alluded in the introduction to this paper, have made theoretical contributions on the distinction between forms or kinds of knowledge (e.g. Bernstein 1999; Winch 2013; Young 2003b), albeit from different perspectives. While Bernstein adopts a predominantly sociological view on the topic, it is particularly Young’s work (discussing Durkheim and Vygotsky’s ideas) and Winch’s work (following Brandom’s ideas) that resonate with ours. Not only are these scholars concerned with the interrelationship between forms or kinds of knowledge, but they share a common purpose which is to emphasise the importance of epistemology for curriculum design. This reinforces the claim that epistemological considerations have important pedagogical implications.

Current debate is going on with regard to 'knowledge' in vocational education, rather than in 'skill'. For example, Bathmaker (2013) reveals that the state of knowledge in vocational education qualifications in a particular context, is complicated and unstable. She further advocates for a greater consideration of 'knowledge needs' in qualification design, "so that vocational qualifications genuinely enable progression, whether to employment or to higher levels of education" (Bathmaker 2013, 87). Also, Hordern (2014) examines how vocational knowledge is re-contextualised in the curricula, pedagogy and workplaces. Although we disagree with the emphasis made on 'putting knowledge to work' (as we pursue individuals’ personal and professional development as the main goal, regardless of the...
immediate applicability of knowledge), we consider this study important to understand the meanings of the notion of 're-contextualisation' (as borrowed from Bernstein) and its relevance for debates concerning vocational knowledge in curriculum and pedagogy. Finally, Höhns' (2018) study about the importance of discourse in pedagogic practice in company learning, despite the fact that we do not share the same epistemological assumptions, is elucidating and relevant in our research context too. Indeed, the proposed framing modalities of pacing and the framing modalities of the selection and sequencing of training content are recognisable in the context of CPT-instruction. To summarise, these three studies focus primarily on the vertical co-operation of action layers (Sloane 2014) from the micro to the macro levels, with an emphasis on the governance sphere. Although our interest and effort are oriented towards the study of the learning process, the governance sphere is complementary to our study too, as it opens future opportunities to strengthen the positioning of our study in a particular context.

Conclusion and Implications
Our argument throughout this paper has been that, if we are to disentangle further the theory-practice integration in any particular domain, the first step is to grasp how key actors in such a context conceive of theoretical knowledge, practical knowledge and, most importantly, the relationship between these kinds of knowing. In line with this, our study sought to generate and synthesise qualitative data in order to offer a lens through which to interpret subjective and intersubjective perspectives on forms of knowledge and the relationships between them. We have advanced a map that depicts: (a) several forms of knowledge that respond to conceptions of theory or conceptions of practice; (b) the relationships between these forms of knowledge in terms of activities; and (c) the multiple agents in charge of accomplishing each connecting activity. Without this model, we may overlook differences in conceptions and attempt to understand others through our own conceptions or received ideas.

First, the epistemological beliefs of the actors became apparent through the criteria that they used in categorising pieces of knowledge. In general, people do not hold strong dichotomous views on knowledge. In other words, their conceptions appear to be more sophisticated than naïve (in certain aspects and to certain extents). However, what counts as theory and as practice is relative to the point of comparison and dynamic. The implication for practitioners resides in the awareness and understanding of each other’s perspectives in order to facilitate the integrative learning processes of the students. This entails reaching
congruence (not necessarily consensus) for the sake of the students, while exploiting any tension to maintain a sound balance in the interplay (Jørgensen 2004) between the needs of all actors. Reaching congruence without abandoning idiosyncratic views is in line with conclusions from past research on the learning potential of ‘boundary crossing’ across different sites (Akkerman and Bakker 2011). In particular, we refer to the conclusions that learning is "grounded in the notion of dialogicality […] without implying or seeking homogeneity" (Akkerman and Bakker, 150) and that the ambiguous, unspecified nature of boundaries "trigger dialogue and negotiation of meaning" (Akkerman and Bakker, 150).

Second, each relationship between forms of knowledge seems to have a very particular purpose (e.g. validation) that another relationship is not able to fulfil. One of these relationships, explanation, stands out for its strong prevalence. Due to its markedly social aspect and its potential to connect distinctive normative domains to each other, it seems appropriate to interpret such social activity further in inferentialist terms as ‘game of giving and asking for reasons’ (Brandom 1994, 1995). The implication of the present investigation for further research on the integration of forms of knowledge resides in the underpinning for the selection of an inferentialist framework.

Third, the activities that relate forms of knowledge are often carried out by multiple agents. The students seldom build relationships alone, rather they draw upon the guidance of more knowledgeable individuals. This idea is embraced by Vygotsky’s (1987) well-known concept of a ‘zone of proximal development’. This conclusion adds arguments for maintaining a focus on explanation as a crucial relationship between forms of knowledge. In some particular cases the relating activities are carried out by ‘external’ agents (i.e. people other than the key actors) who have privileged access to particular forms of knowledge. It follows that the integration of theory and practice as a whole is inevitably collaborative, as the pieces of knowledge that need to be integrated are distributed amongst multiple agents. The implication is that we need to question the expected centrality of the learner in the process of relating forms of knowledge. Therefore, if we wish to work on what facilitates that process, rather than overemphasising the engagement of individuals, we should certainly consider the affordances of the workplace as well.

To summarise, the present study reveals the complexity of knowledge networks that the unspoken conceptions of individuals often conceal. In addition, it reveals a multiplicity of actors who embody these relationships. We therefore contend that this study is particularly useful for continuing research on the overall integration of theoretical and practical
knowledge, as it offers a rationale for a conceptualisation of integration as a network, as well as for the selection of an inferentialist framework.

References


Appendix A
Table 4. Procedure of data collection for serial (recurrent sessions with mentors and tutors, separately)

<table>
<thead>
<tr>
<th>Session 1</th>
<th>Task</th>
<th>Session 2</th>
<th>Task</th>
<th>Session 3</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration</td>
<td>Member check* and preparation</td>
<td>In-depth discussion</td>
<td>Member check* and preparation</td>
<td>Elaboration</td>
<td>Member check*</td>
</tr>
<tr>
<td>e.g. folk conceptions</td>
<td>e.g. select an operation or process segment; analyse aspects in a given matrix</td>
<td>e.g. discuss task: how to distinguish T&amp;P aspects</td>
<td>e.g. select an operation or process segment; prepare an explanation for a role play</td>
<td>e.g. interactive explanation (role play mentor-researcher); role play analysis by the group</td>
<td>e.g. in what way was participation useful</td>
</tr>
<tr>
<td>on T&amp;P</td>
<td>e.g. beliefs on the goal of dual learning in terms of T&amp;P</td>
<td></td>
<td>e.g. what kind of feedback is expected from this study</td>
<td></td>
<td>e.g. what kind of feedback is expected from this study</td>
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</tbody>
</table>

*Member check of previous session’s summary and researcher’s interpretations, and input for researcher to adjust following session’s schedule (when applicable).
### Appendix B

Table 5. Forms of ‘theoretical knowledge’.

<table>
<thead>
<tr>
<th>Forms of theoretical knowledge</th>
<th>Features</th>
<th>Whose conception</th>
</tr>
</thead>
</table>
| Pure theory                    | • hardly ever engaged consciously  
                                  • often equated to performing calculations  
                                  • generally applicable  
                                  • books as main source  
                                  • the school as the primary learning environment | mentors, tutors, students |
| Applied general theory         | • needed to reason  
                                  • learnt primarily at school  
                                  • assumed to be readily transferable  
                                  • seen in opposition to pure theory  
                                  • seen as a condition for acquiring practical knowledge | tutors, students |
| Situated theory                | • *in situ* knowledge  
                                  • often describes cause-and-effect relationships  
                                  • the most fundamental knowledge accessible to operators  
                                  • codified and explicit  
                                  • learnt by referring to codified sources; refined through experience  
                                  • high perceived applicability  
                                  • the workplace as primary learning environment | mentors, students |
| Self-constructed theory        | • the result of intentionally organised, purposeful experiences  
                                  • origin in the actors themselves  
                                  • driven by a pressing need  
                                  • supports further operational activities | mentors |
| Implicit theory                | • personal cause-and-effect constructions to explain observed phenomena  
                                  • multiplicity, (often) contradictory | students |
Table 6. Forms of ‘practical knowledge’.

<table>
<thead>
<tr>
<th>Forms of practical knowledge</th>
<th>Features</th>
<th>Whose conception</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observational practice</td>
<td>• knowledge of what happens and plausible reasons why</td>
<td>mentors, tutors, students</td>
</tr>
<tr>
<td></td>
<td>• often equated with accumulated experiences</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• acquired primarily through active observation of other people and events, but not through the learner’s own action</td>
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<td></td>
<td>• more general than context-specific</td>
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<tr>
<td></td>
<td>• the workplace as the primary learning environment</td>
<td></td>
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<tr>
<td></td>
<td>• relevance associated with noticing details, triggering reasoning and reducing levels of abstraction</td>
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<tr>
<td></td>
<td>• evolving nature in the longer run: from observational and cognitive to hands-on and automatic</td>
<td></td>
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<tr>
<td>Functional practice</td>
<td>• readily usable as input for routine operations and problem-solving</td>
<td>mentors, tutors</td>
</tr>
<tr>
<td></td>
<td>• pertains to the operation of equipment, rather than its design</td>
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<tr>
<td></td>
<td>• specific or general, depending on the focus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• acquired in part through scenarios and simulations</td>
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<tr>
<td>Cunning practice</td>
<td>• devious or deceptive</td>
<td>students</td>
</tr>
<tr>
<td></td>
<td>• learnt over time through trial-and-error</td>
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<td></td>
<td>• responds to a logic of the workplace by which the goal justifies the means</td>
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<tr>
<td>Manual practice</td>
<td>• hands-on motor skills (rather than knowledge)</td>
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Orozco, M., Gijbels, D. & Timmerman, C. (2020)

Table 7. Relationships between forms of knowledge. (continues)

<table>
<thead>
<tr>
<th>Relationships in terms of activities</th>
<th>Features</th>
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</table>
| Application                         | • involved primarily job-related tasks such as process monitoring and problem solving  
• use of knowledge in closely corresponding tasks  
• students are not expected to actually apply their knowledge by themselves in the workplace (as they only participate peripherally in the activities of others) |
| Broadening                          | • the 'broadening' of pure theory at the workplace through observational practice  
• often facilitated by tasks, it requires the guidance of the mentor or a colleague  
• by broadening some elements of observational practice have the power to enrich the understanding of pure theory |
| Conversion                          | • only a small part of the conversion of one form of knowledge into the other is done by the students and the operators in general  
• the major part of pure theory is converted into situated theory by engineering suppliers and in-house engineers  
• unidirectional |
| Deepening                           | • referred to as part of the broader learning process  
• appears at instances in which one first observes in practice and subsequently refers to the theory in order to ‘deepen’ that understanding |
| Explanation                         | • frequently highlighted activity by all groups of actors  
• often seen as an ability to identify plausible cause-and-effect relationships; e.g. in using situated theory to help students explain their observations, they develop practical knowledge that is grounded and that triggers further reasoning  
• concerns finding arguments in pure theory for giving reasons for the specificity of instances of applied general theory  
• concerns giving reasons for observational practice by appealing to several forms of theory |
| Giving meaning                      | • the meaning of knowledge as a source of interest and motivation amongst students; e.g. observational practice providing meaning to relatively abstract forms of knowledge that are based on numbers, magnitudes, and symbols  
• making knowledge meaningful often conceived of as: (a) acquiring a feeling for magnitudes, (b) distinguishing and interpreting scaled and non-scaled diagrams or (c) rewording a concept in other terms, or relating the concept to an associated concept that is easier to represent mentally |
| Interpretation                      | • a 'backward' relationship with which to question and revise prior knowledge  
• only when there is interaction with the chemical process, the feedback towards ‘observational practice’ appears (i.e. the response of the process is taken into account)  
• performed by students only through social learning with the full operators  
• triggered by challenges possed by the chemical process or by external factors such as weather conditions or economic considerations |
Table 7. Relationships between forms of knowledge. (continued)

| Putting things into perspective | observational practice helps students to understand the limitations of theory, e.g. whenever there is a mismatch between their observations and what they would have expected based on the theory  
|                               | a new perspective is often revealed when ‘external factors’ are engaged in the explanations, i.e. site-specific factors or in situ considerations that do not pertain to general process technology (e.g. chemical process integration)  
|                               | a challenging step for the student that does not occur spontaneously and that requires the assistance of the mentor and colleagues |
| Recalling                     | distinguished as a connecting activity on its own  
|                               | observational practice claimed to assist the recall of theoretical knowledge, regardless of whether recalling is related to understanding |
| Understanding                 | there coexist different conceptions of what it means to understand something, e.g. at least four conceptions amongst the students alone:  
|                               | resolving an inconsistency or a contradiction  
|                               | the ability to form an image of the object of understanding  
|                               | the ability to provide explanations  
|                               | spontaneously getting used to something just by doing it repeatedly |
| Validation                    | observational practice (which was often equated to accumulated experiences) was regarded as confirming or validating what had been learnt before (by providing evidence)  
|                               | observational practice seen a source of evidence that students may need in order to value the corresponding theory, to confirm that theoretically described phenomena ‘actually exist’, and, finally, to validate theoretical knowledge and accept it as true (at least provisionally) |