# Empirical conceptualisation of integrative learning : a focus on theory-practice integration in technical vocational education and training

# Empirical conceptualisation of integrative learning. A focus on theory-practice integration in technical vocational education and training.

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## Abstract

The integrative learning of theory and practice has been widely recognised as a cornerstone of today's technical vocational education and training (T-VET). Considerable uncertainty persists regarding how to construe such integrative learning, let alone regarding how it proceeds or what it generates. This article reports an in-depth qualitative study designed to clarify the concept of integrative learning by advancing current understanding of what constitutes the integrative learning of theory and practice (ILTP) in terms of both its process and its outcome aspects. In all, 48 key actors in dual T-VET (students, tutors and mentors) participated in serial focus groups, class observations and apprenticeship observations. The constant comparison method was used to generate a description of both the learning process and the learning outcome based on descriptive axial dimensions along which learning and knowledge were positioned. More specifically, we distinguished three process dimensions (intentionality, time of the prompt and locus of learning) and three outcome dimensions (purpose, logic and locus of integrated knowledge). All in all, the findings can be understood only in consideration of co-existing perspectives on integration according to which the separation of theory and practice is more or less marked. The article discusses expected implications for practitioners and future research.

## Keywords

Integrative learning, Theory and practice, Technical vocational education and training, Dual school-based and work-based learning, Grounded theory

## Introduction

Integration and integrative learning have been identified as being crucial to initial vocational learning and to the development of further professional expertise (Beckett 2000; Gessler and Howe 2015; Guile 2006; Hiim 2017; Tynjälä 2008). This integration, moreover, has often been advanced in terms of paired entities, such as mind and world, school and workplace, theory and practice, concepts and experience, or formality and informality. Consequently, all these entities are proposed to constitute the very objects of integration. Particular concern and debate, however, have been devoted to the integration of theory and practice, which is even regarded as a requirement for the development of vocational and professional expertise (Tynjälä 2008). Theoretical concepts rooted in actual professional practice are important in all vocations and professions in modern society, as they concern descriptions of how and explanations of why, in addition to offering broader social perspectives on vocational practice (Hiim 2017). In other words, a notion that vocational (or professional) knowledge consists largely of manual skills is highly questionable within a technological and complex society, as a considerable number of vocational tasks require advanced practical *and* theoretical understanding. For this reason, the 'recognition that vocational knowledge and high-level competence include theory' (Hiim 2017, p. 12) is of the utmost importance in technical vocational education and training (T-VET).

Despite the widely acknowledged relevance of integrative learning in T-VET and the continuously growing body of research in this field, little has been said with regard to what such integration actually entails or how it proceeds (Barber 2012). Moreover, this gap appears to be the result of an unresolved epistemological debate concerning theory and practice (Hiim 2017), as well as of the confusion of 'process variables' with 'process conditions' (Barber 2012). According to Barber (2012), while previous research has attempted to describe the process of integration, it has resulted in a 'mere' inventory of facilitators. However, if facilitators are nothing more than process conditions, such that they do not describe the process itself, what does? Unfortunately, this question has been left unanswered. Past endeavours to theorise the 'integration of learning' in particular contexts and various learning environments (Barber 2012) have resulted only in hierarchically ordered 'types of integration', while failing to unveil what is concealed within the concept of integration. This suggests that the lack of a conceptualisation of integrative learning is impeding further advancement.

The present study represents an effort to clarify the concept of integrative learning by focusing on theory and practice as core objects of such integration. In line with this aim, the central question guiding our investigation is as follows: What constitutes the integrative learning of theory and practice (ILTP) in technical vocational education and training? More specifically, this study is intended to advance an empirical conceptualisation of the ILTP construct in initial technical vocational learning by focusing on two distinctive, though related, aspects: the process of learning and the expected outcomes of this learning process.

To conclude this introduction, we draw attention to a great deal of philosophical work done on the conceptual exploration of vocational knowledge (e.g. Winch 2010). Our empirical approach to this matter reflects our interest in understanding key actors in T-VET through their own perspectives and by no means represents an effort to validate existing philosophical knowledge. Before presenting our methods and results, we address the notion of integration in terms of its objects (i.e. what is to be integrated), its agents (i.e. who performs the integration) and epistemological perspectives. We then focus on process and outcome as interrelated aspects of integrative learning.

## The notion of integration: setting the scene for integrative learning

### Objects of integration

When studying integrative learning, the question arises of what is to be integrated. Different objects taken together may provide a holistic view and harmonise with each other in order to add different dimensions to the concept of integration. Our interest in the integration of theory and practice, therefore, should not blind us to other objects that are potentially relevant to T-VET. Beyond the integration of various kinds of knowing (e.g. theoretical and practical), it may be expected that students need to (deliberately) connect, e.g. contexts, disciplines, learning strategies, formality and informality, rationales, conceptions and concepts. The idea of objects of integration other than theory and practice has been supported by other authors. For example, scholars have suggested a need to integrate contents within disciplines, contents between disciplines and contexts of learning with contexts of use (Barber 2012); to integrate 'individual events' in order to emphasise that they are not unrelated, but that they respond to the same ideas (Songer and Linn 1991); and to integrate kinds of reasoning (Beckett 2000; Schaap, Baartman and de Bruijn 2012). These arguments aim to raise awareness of different views concerning what is to be integrated, while emphasising that other proposed objects are not necessarily incompatible with our focus on theory and practice.

Now, concentrating on our core objects of integration, we deliberately avoid providing a tight definition of 'theory' (or theoretical knowledge) and 'practice' (or practical knowledge). Such definitions, we argue, are restrictive and not conducive to our present research aim; these definitions may cause us to overlook differences in conceptions (i.e. differences in personal epistemologies), as if we were attempting to understand others through our own partial ideas.

### Agents of integration

Having discussed the question of what is to be integrated, first broadly and then focusing on our objects of interest (i.e. theory and practice), we turn next to a question that arises when building a notion of integration. This refers to who performs the integration or, in other words, who are the agents of the integrative learning process.

It is ultimately for the students to reconcile everything they learn, as well as how they engage in learning in different contexts and situations. Such propositions about learner centrality are in line with a constructivist view on learning and find support in extensive agreement among scholars on who actually carries out (albeit to varying extents) the integrative learning activities. Indeed, it has been proposed that it is the students who act as the agents of integration (Billett 2008, 2009; Cedefop 2015; Tynjälä 2013). This is, however, not to deny the wide range of contextual factors (e.g. affordances of the learning environments) and essential mediating tools (Tynjälä 2008), such as the guidance of a more knowledgeable person, that play a role in the process of integration.

## Epistemological perspectives

At this point, we continue to form a notion of integration by appealing to epistemological considerations. This adds important insights to the previous discussions on the objects and agents of integration.

From an epistemological perspective, the notion of integration of theory and practice ushers in a movement away from dichotomous thinking about these kinds of knowledge (and thus towards a resolution of the theory-practice duality). In this respect, while looking for the meaning of vocational or professional knowledge, both Guile (2006) and Hiim (2017) have reviewed the legacies of various thinkers and distinguished a number of rationales in terms of their epistemological roots, as well as their pedagogical implications. One important conclusion is that the position that each rationale takes on the integration of kinds of knowing (e.g. theoretical and practical) carries a distinctive power to resolve the theory-practice duality.

Robert Brandom's idea of 'inferentialism' (1995) has been proposed as a major contribution for resolving the theory-practice duality (Guile 2006, 2010). Following this line of thought and referring to the distinction between theory and practice, Guile proposes that 'we do not have to abandon this distinction because it does not reflect a dualism, rather it reflects the different outcomes that flow from the specialised activities in which we engage' (Guile 2006, p. 256). This proposition (which builds on Vygotsky, McDowell and Brandom's work) further implies that our interpretation of new concepts is best accomplished by the social practice of inference: the 'game of giving and asking for reasons' (Guile 2006, 2010).

Other researchers have also appealed to inferentialist ideas, albeit as a part of a broader theoretical framework. This is the case for prior research on the contextualisation of vocational knowledge (Heusdens, Bakker, Baartman and De Bruijn 2016), as well as for continued work on the characterisation of students' vocational knowledge (Heusdens, Baartman and de Bruijn, 2018). Despite major differences between these pieces of research and ours (in terms of focus, underlying purpose and methodology), we share with Heusdens and colleagues the same commitment to avoid simplistic theory-practice dichotomies.

## Integrative learning as process and as outcome

We complete this introductory section about the notion of integration by acknowledging both the process and the outcome aspects of integrative learning. The need to distinguish process from outcome as two distinctive units of analysis arises from both theoretical and methodological considerations, given our aim of disentangling the ILTP construct. When seeking to theorise the concept of integrative learning, it is necessary to distinguish the kind of questions that are raised in this regard. Rather than asking 'whether' students integrate learning, a more relevant question concerns 'how' they do so (Barber 2012). This 'how' question refers to a process, whether in the short term or the long term. At the same time, Barber points out that the 'integration of learning' can be seen as 'a primary outcome' of education (Barber 2012) or, in other words, as a learning objective. This proposition confers a second nature to integrative learning as, beyond the process aspect, it also recognises the outcome aspect. Nevertheless, the mere proposition does not provide any simple *a priori* means of discriminating between process and outcome. In echoing John Dewey, it has been claimed that 'the process and goal of education [read learning] are one and the same thing' (Segers and Van den Haar 2012, p. 55).

## Research questions

Up to this point, we have presented a justification for the present study and constructed a notion of 'integration' to increase awareness of and sensitivity to what is involved within this topic. As stated before, this study responds to a need for conceptualisation of the ILTP construct and, in line with this, our central question is as follows: What constitutes the integrative learning of theory and practice in technical vocational education and training? We have broken this question down into its two interrelated aspects: the process of learning and the expected outcome of this learning process.

## Methods

In this section, we present a brief rationale for the selection of methods, context and participants, followed by a description of the empirical settings and, finally, our procedures for data collection and analysis.

### Rationale

As explained in the introduction, this investigation aimed to develop a framework that, we contend, is currently missing. More specifically, we sought to conceptualise the ILTP at a micro-level of analysis and, therefore, the objects of our study were both the learning process and its intended outcomes. Our efforts to build such a conceptualisation were informed by our ontological and epistemological assumptions, as well as by existing knowledge (as introduced in the previous section) in terms of sensitising concepts (Mortelmans 2007), whereas no *a priori* theoretical framework was involved. Consequently, we set out to formulate and advance a theory that was grounded in the accounts and behaviours of those who engage in T-VET. For these reasons, we adopted a grounded theory approach (Glaser 1992; Glaser and Strauss 1971; Strauss and Corbin 1998).

Briefly, our ontological and epistemological assumptions were as follows:

We adopted a consistent basis starting with a realist ontology, i.e. "a commitment to the existence of a real, although not objectively knowable world" (Maxwell 2004, p. 247), while acknowledging multifaceted accounts of 'reality' according to an interpretative epistemological position (O'Reilly 2012). A non-dualistic epistemology was embraced, i.e. the distinction between 'theory' and 'practice' does not imply a hard separation and it has an analytical purpose only (Guile 2006). Such positioning made it possible, e.g. during data analysis, to distinguish the specificity of each kind of knowing, while acknowledging their intimate and even dynamic relationship. Furthermore, we saw people as initiators of their own actions rather than mechanically responding to contexts, in line with a voluntarist regard of human nature (Cohen, Manion and Morrison 2011). And, finally, the methodological basis was idiographic, what is reflected in our interest in the participants' individual perceptions, experiences and co-constructed meanings (Cohen et al. 2011).

## The context

The investigation took place within the context of dual learning (i.e. alternating school-based and work-based learning) at the post-secondary and higher educational levels and, more specifically, in the field of chemical process technology (CPT). More particularly, the post-secondary programme consists of a one-year intensive course that is open to graduates from any secondary school. For its part, the higher education programme pertains to a one-year intensive specialisation within a three-year professional bachelor training in chemical process technology and is only accessible to students who completed the first two bachelor years. In both cases, students are granted access to the dual variant following a joint selection procedure carried out by the schools and the participating companies. Upon successful completion of these programmes, students receive certification as process operators, which qualifies them to work in a number of industrial manufacturing sectors. The selected context was particularly well suited to our study because the corresponding pedagogical approach takes theory-practice integration as its central goal, i.e. the co-instruction provided by both the school and the work environments deliberately aim at 'coupling' theory and practice at the level of the individual learner.

## The participants

In all, 48 key actors in dual T-VET (students, tutors and mentors) participated in the qualitative data collection. At the time of the data collection, most participants were connected to each other through student-tutor, student-mentor or tutor-mentor relationships. Table 1 provides a summary of the number and characteristics of the participants, and Figure 1 presents a simplified overview of the participants by sub-context.

**Table 1**
Participants in the empirical investigation

| Group of actors | Description |
|---|---|
| Students | Twenty-seven students (between the ages of 18 and 25 years) at the post-secondary level in three different schools. |
| | Three students (between the ages of 25 and 30 years) at the higher educational level in one tertiary school. |
| Tutors | Seven tutors from four different schools.<br>Tasks: teaching (e.g. chemistry, physics, instrumentation and process control, and mechanics) and supporting students in their workplaces.<br>Extended teaching experience and limited or no work experience in the industry. |
| | Two tutors from one tertiary school.<br>Tasks: comparable to those described above and, recently, a more coordinating role. |
| Mentors | Nine mentors from four different chemical (or petrochemical) companies.<br>Tasks: everyday responsibilities in the production processes, combined with the mentoring of students and starting operators.<br>Extended experience (10-30 years) in production, varying experience (2-20 years) in mentorship and limited or no formal pedagogical training. Two participants also held coordinating roles. |

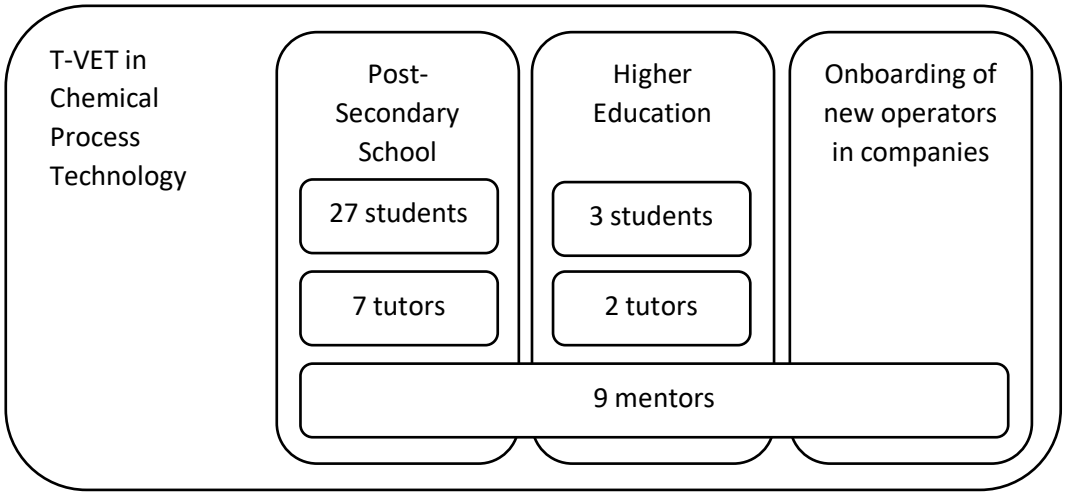


**Fig. 1**
Simplified overview of participants within the context of Chemical Process Technology

The selection of the participating companies proceeded partly by convenience, but mainly on a purposive basis (in consideration of these companies' pioneering role in co-designing alternating learning environments and their intentionality towards integrative learning). The access to purposively selected companies was facilitated by an independent consultant. Subsequently, within each company the human resources managers helped identify the most experienced and engaged mentors. In the case of schools, their tutors and students, the entire population concerned in this dual-CPT course was invited to participate. All participants joined the study on a voluntary basis after granting formal informed consent.

## Methods for data collection

The empirical investigation proceeded according to a qualitative approach with method triangulation. Focus groups were selected as a first data-collection technique, given our interest in the participants' intra-subjective interpretations, perceptions and experiences, as well as our expectation that the negotiation process would yield much richer accounts and illustrations than would single interviews alone. In addition, we aimed to obtain more factual insight into how the participants proceed (i.e. how they actually reason and eventually act or, at least, how they articulate potential actions). To this end, non-participatory observations were conducted both at school and in the workplace. This research design allowed a dialogue between the two methods of data collection, with each providing its own insights. Moreover, the understanding of the participants' perspectives we gained during the focus groups informed our interpretation of the observations.

## Settings

Two kinds of activities were observed: interactive class presentations (at school) and evaluative-formative sessions (in the workplace). Both of these activities provided natural settings for the observations. The main difference between the two settings was the presence of the mentor in the workplace. Other differences (e.g. the accommodation) seemed irrelevant. Given the topics under

discussion, it was reasonable to expect that the students would be concentrating primarily on the production plant or on the control room, regardless of their actual physical location.

During the interactive class presentations, each student had the opportunity to share experiences (after having completed an apprenticeship period) in a plenary session with their tutor and peers. Specific details regarding what the individual students have learnt in very different companies are of interest to their peers in the audience. For their part, the evaluative-formative sessions are central to the tutoring and mentoring of students, as they intend primarily to evaluate the progress of students and to identify areas in which they require additional support. Each session centred on a student's presentation, which included several visual aids. Such settings allowed the observation of interactions amongst student, tutor and mentor.

## Procedure for data collection and analysis

The qualitative data collection took place in two waves. The first wave consisted primarily of focus group discussions, supplemented by semi-structured interviews. The focus groups were unmixed, i.e. students, mentors and tutors participated separately. The second wave consisted of non-participatory observations. The main aspects of the data collection process are summarised below in Figure 2.

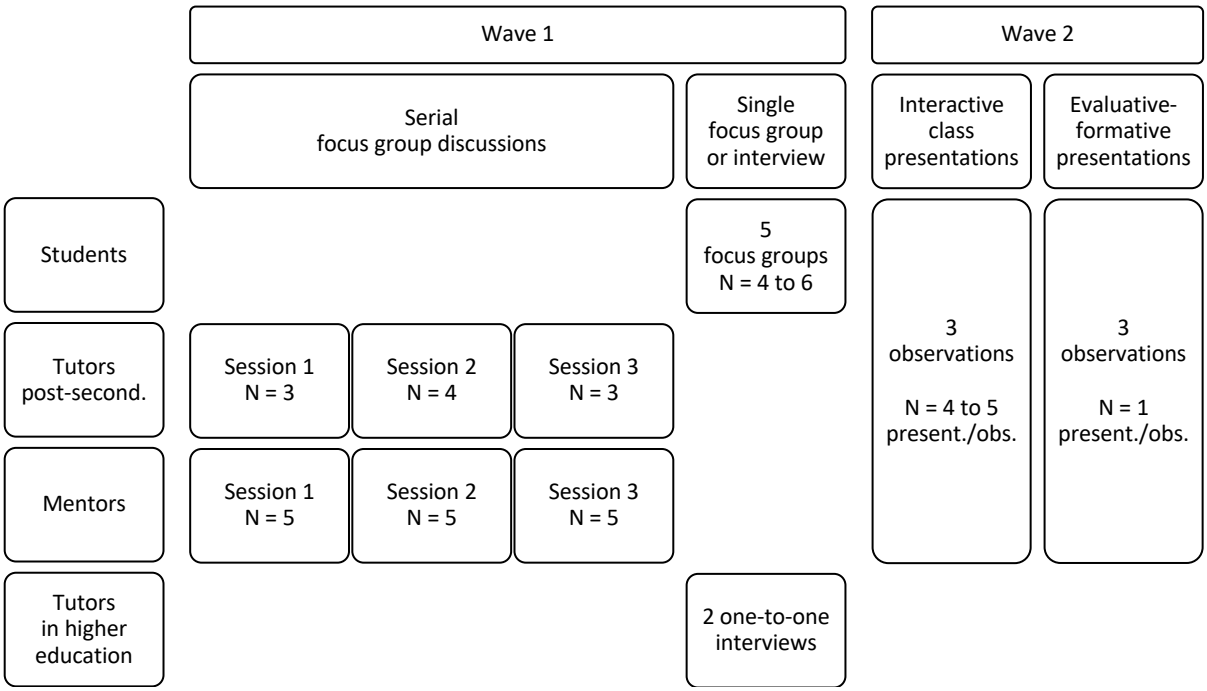


**Fig. 2**
Overview of the data collection techniques as applied

Except for the students, the focus group discussions were organised in series of three sessions, each with nearly the same participants but each with a different purpose (i.e. exploration, in-depth discussion, and elaboration and exemplification). Between the sessions, the participants engaged in consultations and completed assignments. This serial approach made it possible to screen the data obtained between sessions. A summary of the questions that were posed to the participants, as

extracted from the schedules that were actually used, is available on request. We looked to both our research aims and sensitising concepts to guide the design of the data-collection instruments.

All of the focus groups (90 minutes each) were audio-recorded. During the observations of class presentations (15-45 minutes each) and evaluative-formative sessions (60 to 135 minutes each) field notes were taken, without any structured observation scheme.

The following examples represent the type of questions asked during the focus group discussions. The first example corresponds to session 1 with mentors (or with tutors) and explored perceptions of the goal of learning. The second and third examples are extracted from the schedule used in single sessions with students.

1. *What should these students ideally achieve in their programme? How would you describe the ideal goal?*
2. *In what ways could they learn this specific job by attending school only, thus without the workplace?*
3. *In your course description you can read that dual learning entails 'learning theory through practice'. What does this mean to you? Give examples.*

Intertwined phases of data collection and preliminary analysis allowed us to estimate that data saturation had been achieved for the purpose of the inductive analysis. All transcriptions and field notes were further analysed (assisted by software for qualitative analysis) in successive coding phases, in which the data were gradually incorporated in order to render the themes progressively richer and more accurate.

Patterns in the data were sought using 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), extended by visualisations (Miles and Huberman 1994) and the extensive use of memos and annotations (Mortelmans 2011). We kept a record of the coding steps taken in our research protocol, including the bases on which coding nodes where created, merged, re-labelled or abandoned. While the coding was performed by the first author alone, all categories were discussed with the second author and any doubtful instances resolved in mutual agreement.

## Results

In this section, we present the results of our analysis, accompanied by selected illustrations to support our claims. We start by presenting evidence of two co-existing perspectives on integration. We then describe both the integrative learning process and the intended outcome, focusing on their dimensions. These findings are summarised in Table 2.

**Table 2**
Overview of the results

| **Co-existing perspectives: Between & Within Integration** | |
|---|---|
| **Integrative Learning: The Process** | **Integrated Knowledge: The Outcome** |
| **Dual learning**:<br>Description of the pedagogical approach<br><br>Dimensions:<br>• Intentionality<br>• Time of the prompt<br>• Locus of learning | **Insight**:<br>Description of the intended result of the process<br><br>Dimensions:<br>• Purpose<br>• Logic<br>• Locus of integrated knowledge |

### Between-integration and within-integration

Close examination of discourses and behaviours revealed the co-existence of primarily two distinctive views concerning what is to be integrated. Throughout the integrative learning process, it is possible to distinguish instances in which there may be separate forms of knowledge responding to 'theory' and 'practice' from instances in which integration refers to concepts belonging to the same form of knowledge, the same discipline or the same line of reasoning. We labelled the former category of instances as 'between-integration' and the latter as 'within-integration'.

The between-integration perspective emphasises a preferred learning environment within which to acquire some form of knowledge (e.g. theory is regarded as a school matter). Moreover, there is a conviction that mastery of one form of knowledge does not necessarily imply mastery of the other. According to this, people need to engage the individual forms of knowledge deliberately, if they are to give a complete explanation. It is noteworthy that there was no attempt to rank theory and practice according to a hierarchy. For its part, the within-integration perspective emphasises the explanatory power of what has been learnt, regardless of the origin of such knowledge. Within-integration, thus, does not involve linking the 'concept of temperature' to the 'practice of temperature' or linking the 'concept of pressure' to the 'practice of pressure'. Rather, within-integration consists of linking two concepts (in this case, temperature and pressure), assisted by what has been learnt during practice. Moreover, such linking makes it possible to draw inferences in order to explain what happens or has happened, and to predict what can or will happen. Such links do not emerge automatically.

Between-integration:

> *'Those insights are a combination of theory and practice: Someone who is strong in theory will understand faster […] but perfect theoretical knowledge doesn't mean that you can turn it into practice in the field when something must happen. You need a good combination of both.' [M-FGD-a]*

Within-integration:

> *'To me, it's when you can say that the instrument is mounted on top of the pipe because there's a wet gas flowing inside and […] because you want to measure the temperature of the wet gas when it leaves [the dryer]. And … the instrument is a thermocouple because for those particular process conditions another instrument [a PT100] wouldn't suit. So, when you're able to give such an explanation for why that specific instrument has been installed in that specific position, then you've coupled theory with practice.' [S3-FGD]*

Distinguishing between-integration from within-integration is useful to understand that 'integration' does not necessarily have to be conceived of as a bridge between various forms of knowledge. Indeed, 'integration' may also refer to the construction of chains of reasoning without specifying whether the building blocks consist of principles or of empirical observations and experiences. Furthermore, between-integration and within-integration perspectives appear to be intertwined. The emphasis on the theory-practice distinction (put by the former perspective) does not negate the relevance attached to giving reasons (according to the latter perspective) as a means of understanding and learning.

The quote presented as an illustration of within-integration represents an example of integration of theory and practice taking place. From this rich passage, it is possible to distinguish the agent of integration, several objects of integration and the integrative inferences made (among many other inferences that may be expected, although they remain implicit).

## Integrative learning as process and as outcome

In the actors' discourses, the notion of 'integration' appeared with two different meanings. On the one hand, it was used with reference to the learning process and, on the other hand, it referred to the result or intended outcomes of this process. For this reason, it is useful to focus on the process-outcome distinction in order to acknowledge both their particularities and their dialogical relationship.

The process:

> *'The students grow throughout that year, such as you expect them to do, in terms of knowledge, in taking initiatives, as person and as team member'. [M-FGD-a]*

The outcome:

> *'The students will have much better insight into what actually happens […]. Better insight and, therefore, increased reaction speed in the event of problems in the longer term'. [T1-FGD-a]*

The dialogical relationship:

> *'Actually, I think that, after graduation, we'll benefit more from the insights we're acquiring than we will from the raw theory […]. The logical couplings, the logical thinking: that's what will remain, and that's what we're learning here'. [S4-FGD]*

These brief illustrations have been taken out of the context of the data collection, in which all discussions were targeted and precisely about integrative learning of theory and practice. Therefore, the reference to 'grow in terms of knowledge' necessarily refers to the process of integration, while the reference to 'insight' necessarily refers to the outcome of integration.

## The process description

The learning process is seen in a variety of ways, including as professional and personal development, as a bare stepwise approach to contents, and as mirroring an entire instructional strategy. The latter view is illustrated in terms of coordination between learning environments (e.g. the classroom and labs at school, the simulated settings and the workplace). The integrative learning process can indeed be described in terms of the pedagogical approach used in 'dual-learning' programmes. Briefly stated, students engage in combined school-based and work-based learning in such a way that most of the curriculum content is learnt in the workplace. This arrangement thus stands in contrast to 'learning here, applying there' approaches.

> *'I prefer to see those steps much more in parallel or disarranged than in a linear sequence […]. In that way, you get a structured organisation of theory, simulated learning environment and practical application. And the closer you get those three to each other, the most efficient your instructional process is. […] At times, the students come back to learn new theory so, in fact, there are steps that are repeated a number of times.' [T1-FGD-a]*

At school, learner activity involves more than only listening. The classes are interactive, students give presentations to each other and there are lab activities (for chemistry, instrumentation and

mechanics), as well as computer-based chemical process simulations. Furthermore, the content organisation and distribution over time applied at school is most loosely connected to the learning activities that are conducted in the workplace. In the workplace, part of the learning is formalised, as students typically proceed through a series of steps that actually resemble the onboarding trainee programmes for starting operators that are used in many chemical manufacturing companies. At the same time, the learning occurs just as much, if not more, through everyday observation and (peripheral) participation in the tasks of the teams. Furthermore, most of the learning appears to occur in the workplace, and not at school.

> *'You have to dedicate a lot of time to new people who're just coming from school. It takes four to five years in our unit. […] Others claim that it takes an operator eight years to master a complex process. But it depends on the person, on the quality of support they get and on whom they learn from.' [M-FGD-b]*

There is no evidence that a rather loose connection at the instructional design level might result in superficial integration at the learner level.

### The process dimensions

In describing the learning process, albeit in terms of the pedagogical approach, we distinguish three dimensions that make it possible to synthesise the observed process features: intentionality, time of the prompt and locus of learning. These dimensions are displayed in Table 3 below.

First, with regard to intentionality, we observe that integrative learning is primarily deliberate, since learning is highly formalised (including in the workplace) and because incidental opportunities to learn are difficult to identify. Second, with regard to the time dimension, it is not possible to indicate (based on predominance in the data) the point in time that best features the stimulus of integrative learning. Third, with regard to locus, integrative learning appears to be a highly individual process, partly because socialisation into work teams is favoured over peer-to-peer learning.

**Table 3**
The dimensions of integrative learning

| Axial dimension | Extremes | Illustration |
|---|---|---|
| **Intentionality** Refers to learning being or not being the main purpose of activities. | **Deliberate** Engaging in planned reasoning or other activity with the purpose of learning. | *'An operator shows you a process flow diagram […], he grabs it and goes with you to the field: […] they help you understand. And then you have to draw a new diagram on your own. And because you've drawn it yourself, you know much more: […] then I could integrate the new theory much more easily'. [S4-FGD]* |
| | **Incidental** Opportunities to learn are by-products of planned or unplanned situations. | *'I always tell my students: "once such an upset occurs, make sure you understand what's going on, or ask for an explanation afterwards"'. [T1-FGD-b]* |
| **Time of the prompt** Stimuli for learning may originate at different points in time. | **Past** A stimulus in the past is linked to new experiences. | *'We have a neutralisation unit, the simplest neutralisation that exists […], but … it's all in an organic medium and that makes the situation completely different. […] And yet, it's interesting that they've already learnt the theory, so they know [at least] that during the neutralisation, a salt is formed and heat is generated'. [M-FGD-b]* |
| | **Current** A present stimulus triggers incidental noting of facts, ideas or learning opportunities. | *'At any time, something can happen that shifts your attention […]. If two chemicals came into contact while they were not supposed to … operators know immediately what they have to do but … you want to know it too: how to react all of a sudden, depending on which compounds …'. [S2-FGD]* |
| | **Future** Current learning is stimulated by an expectation or in view of an activity. | *The tutor clarifies the different focus of forthcoming apprenticeship periods: "in the second period, you will go deeper into […] instrumentation and process control". [Obs2]* |
| **Locus of learning** Where learning happens, whether shared goals are exploited | **Individual** Each student learns on their own: there is no peer-to-peer interaction. | *'No, we don't know what each one of us has learnt or experienced in our respective workplaces'. [S1-FGD]* |
| | **Collective** Peers learn together, pursuing the same or similar goals. | Negative evidence: *Mentors prefer to have only one student per shift, in order to prevent them from forming a subgroup. More specifically, companies favour each student's integration into the operators' teams over students' peer-to-peer collective learning. [Obs2, Obs3]* |

## The outcome description

Profoundly integrated knowledge (with the integration being either between or within forms of knowing) is largely articulated in terms of 'insight'. As a label, 'insight' is used in different ways (e.g. in opposition to declarative knowledge and in opposition to meaningless knowledge). As a concept, integrated knowledge is conceived of as a discovery, as the ability to give and ask for reasons, in terms of problem-solving skills and with reference to the potential to continue learning.

A first conception of integrated knowledge is that of a discovery. A discovery refers to the realisation that one's mental model matches the actual object (e.g. parts of a piece of equipment fit within a mental representation of its working principle).

> *'I think that you've made the link when you're facing the machine and then you see it as in a picture … okay, that's it!' [S3-FGD]*

The ability to give and ask for reasons is by far the most prevalent conceptualisation of integrated knowledge. Most actors coincided in their descriptions of the intended output as the ability to state the underlying reasons for observations. There was less consensus, however, concerning the extent to which it is appropriate to continue searching for reasons, as well as with regard to the relevance attached to the action that is ultimately taken as a result of reasoning. In addition, a comprehensive explanation extends beyond the working principle of an instrument or piece of equipment to include reasons related to the particular chemical process (e.g. selection criteria and considerations concerning location and mounting). Many more examples can be mentioned and illustrated concerning students giving and asking for reasons. They include explaining how something works in relation to its constituent parts, categorising apparently isolated items under the umbrella of a single concept and disentangling a network of concepts. Furthermore, the conceptualisation of integrated knowledge occasionally extended beyond reasoning alone to include action as well, albeit within a simulated learning environment. In this case, 'insight' is conceived as the understanding of what one is doing (while solving a problem).

> *'They need to know more than what it is and what it is used for. They also need to know what to do when something happens, how they have to react, on what it has an effect, and what can be the cause. […] But you can't expect such a mastery level from our students […]: mastery lies in the far future.' [T1-FGD-a]*

Furthermore, what the actors considered to be a comprehensive explanation was not uniform. Students and tutors primarily referred to issues of 'what', 'how' and 'why', while mentors often added 'what if', in order to account for the use of integrated knowledge in problem-solving. In other words, the mentors' description of integrated knowledge extends beyond the capabilities of the students and novice operators, thus referring to advanced or even expert operators. Eventually, some actors regarded the description of integrated knowledge primarily in terms of reasoning as an idealistic goal, while operators are 'only' expected to solve problems in order to maintain or regain the steady operation of the chemical process.

> *'A shortcut may not be the best thing. But the shortcut that you take is actually someone else's experience: if X happens, then you do Y. And maybe there's less of an insight at that time, but they [operators] know what they have to do.' [T1-FGD-c]*

Finally, the potential to continue learning was also seen as a part of the outcome of integrative learning.

> *'We [the tutors] offer that bit more to the students, aware that their knowledge will flatten out over time and hoping that part of it remains. That is … hoping that they never become one of those operators who […] don't ask themselves any more questions.' [T1-FGD-a]*

> *'The why-question doesn't come up automatically: it's part of the learning process. We need to teach them to pose those questions at all times and eventually they'll come up with such questions themselves. We teach them to do so during the evaluations, and more and more they will reflect in advance: "why is it so?"' [T1-FGD-b]*

### The outcome dimensions

The integrated knowledge that is pursued can be further described in terms of three dimensions: purpose, logic of integrated knowledge and locus of integration. This is displayed in Table 4 below.

First, with regard to purpose, the results indicate that integrated knowledge is driven primarily by functionality, with mastery being an intermediate purpose geared towards performance. Second, with regard to the kind of logic involved, integrated knowledge responds to both truth-seeking and performance-seeking logic, thus oscillating between them. Third, with regard to locus, while integrated knowledge aspires to internal integration (as far as the school is concerned), it tends to rapidly become external under the influence of the division of labour, thus resulting in distributed knowledge.

**Table 4**
The dimensions of integrated knowledge

| Axial dimension | Extremes | Illustration |
|---|---|---|
| **Purpose**<br>Refers to the merit or value of the process: the 'why' or 'what for'. | **Mastery**<br>Knowledge or skill in its own right. | *'When I explain something to someone with so much experience and they say, "yes, you've got it" […], I am convinced that I know it'. [S2-FGD]* |
| | **Functionality**<br>Knowledge being useful to attain other goals (often related to finding solutions to problems). | *'If you encounter the same or a similar problem, you can say 'we solved it that way at that time'. That's something that you can use again. That's a asset students still lack, but someone who has been working in production for several years will certainly cultivate it'. [M-FGD-a]* |
| **Logic**<br>The way of reasoning. | **Truth-seeking**<br>Logical reasoning, including explanations for the best hypothesis. | *P1: The anti-foam is added to the product upstream in the crystallisation step.*<br>*P2: It can be reasonably expected that the anti-foam represents a nuisance during and/or after crystallisation.*<br>*C: Therefore, the anti-foam is probably much more volatile than the product, such that it can escape before the crystallisation begins. [Obs4, adapted]* |
| | **Performance-seeking**<br>Reasoning that pursues a satisfactory result. | *P1: We need the full flow through this pipe.*<br>*[P2: The pipe seems to be partially clogged.]*<br>*P3: If we cause a water hammer, then the clog will crumble and the flow will be restored.*<br>*C: Therefore, let's cause a water hammer. [S5-FGD, adapted]* |
| **Locus of knowledge**<br>Perceived or imagined location of knowledge. | **Internal**<br>Forms or pieces of knowledge concentrated within an individual. | *'To me, it's when you can say that the instrument is mounted on top of the pipe because there's a wet gas flowing inside and […]. So, when you're able to give such an explanation for why that specific instrument has been installed in that specific position, then you've coupled theory with practice'. [S3-FGD]* |
| | **External**<br>Knowledge shared amongst individuals (who become mutually dependent). | *'For problem-solving … most operators don't know the theory but they have books there … full of troubleshooting: "When I get this problem, I have to do that", and if you understand why there is problem, then you can think further than the book. It's convenient to have some background knowledge, but … you can do without it, because it's all been worked out by engineers'. [S4-FGD]* |

## Discussion and conclusions

The purpose of our study was to advance an empirical conceptualisation of the integrative learning of theory and practice (ILTP) in technical vocational education and training (T-VET) by adopting a grounded theory approach. In pursuing this aim, we focused on two related aspects of the ILTP: the process of learning and the expected outcomes of the learning process. Accordingly, we presented a conceptual description of both process and outcome, based on their most predominant features according to three axial dimensions each. Moreover, each dimension was interpreted as a continuum (not a dichotomy) characterised by its two observed extremes. In their turn, these extremes allowed us to propose where the learning process and the learning outcome are positioned along their particular dimensions. One exception to this concerns the time dimension which, unlike the other dimensions, presents a set of discrete positions.

We characterised 'integrative learning' not only as a stepwise approach to contents or as a reflection of an instructional strategy but, moreover, as a process of professional and personal development. In terms of its three dimensions (intentionality, time and locus of learning), we suggested that (1) integrative learning is primarily deliberate, (2) no past, present or future stimuli can be considered predominant and (3) integrative learning is a highly individual process. The process dimensions were presented in Table 3. The first two process dimensions are partially consistent with prior knowledge of non-formal learning (Eraut 2000). Furthermore, we suggest that past prompts are mentioned more frequently because people are more aware of them, such that they are more easily identified and articulated. Finally, we propose that the primarily individual character of the learning process is explained in part by a preference for socialising students into work teams over peer-to-peer learning.

We observed that 'integrated knowledge' is often conceived of as an insight (as opposed to isolated forms of knowledge) and is qualified as deeply meaningful, adaptively transferable and self-sustainable. Consistently, we found that integrated knowledge comprises not only of suddenly discovered connections, but also an ability to engage in reasoning with others, problem-solving skills and even the potential to continue learning. With regard to its three dimensions (purpose, logic and locus of knowledge), we posited that integrated knowledge (1) is driven more by functionality and performance goals than it is by mastery alone, (2) responds to both truth-seeking and performance-seeking logic and (3) tends to move from internally to externally integrated forms. The outcome dimensions were presented in Table 4. While integrated knowledge can be primarily characterised by its functionality purpose according to its first dimension, its position along the second dimension is less straightforward. Indeed, reasoning appears to oscillate between two logics in a yet undefined fashion. Additionally, the evidence suggests that the logic and purpose dimensions are related to each other. We found that students and their instructors apply a 'truth-seeking' logic when the purpose of knowing lies in promoting and demonstrating mastery, while they tend to apply a performance-seeking logic when the purpose of knowing is functional. The logic dimension is supported by existing knowledge on the 'epistemology of practice' (Beckett 2000). Finally, the locus of integrated knowledge appears to be particularly dynamic, moving from internally integrated to externally integrated. This is a striking finding, as it implies that the student's centrality as the agent of integration does not persist. The more students are immersed in a working environment with a strong division of labour, the more other agents come into play. This phenomenon results in knowledge that is as much integrated as it is distributed across multiple groups of people. This raises a question concerning whether integrated knowledge disintegrates over time. If it does disintegrate, it will not be into its original pieces.

We further contend that there is a dialogical relationship between process and outcome. More specifically, process features inform the outcome, while outcome features induce the process. For example, by pairing the various dimensions (as in Table 2), we can speculate that purpose shapes

intentionality and that the different timed prompts predominantly drive one or the other kind of logic. Nevertheless, with regard to the distinctive location of learning and of knowing, there is still more to investigate in order to explain the apparent incongruity of individual learning that leads to external knowledge (i.e. the emergence of mutual dependency). Further analysis could reveal additional cross-relationships amongst the six dimensions.

Finally, we propose that claims about the occurrence (or non-occurrence) of the integration of theory and practice are coloured by the epistemological position of the claimer. Our findings can therefore be understood only in consideration of co-existing perspectives on integration that respond to distinctive degrees of dichotomous thinking about theory and practice. Whereas the between-integration perspective emphasises the separation of theory and practice and the need to bridge them, the within-integration perspective focuses primarily on the use of concepts (learnt in any environment) to build explanations that involve both theoretical and practical considerations. The former is in line with existing knowledge about integrative pedagogies (Tynjälä 2008), while the latter is consistent with existing knowledge about inferentialism (Brandom 1995, 2000; Guile 2010).

In addition to clearly distinguishing between-integration from within-integration, we have highlighted the intertwined nature of these perspectives. The emphasis on the theory-practice distinction does not negate the relevance attached to giving reasons as a means to understanding and learning. This is consistent with the stance that the distinction between forms of knowledge does not reflect a dualism (Guile 2006), rather it guards against the risk of 'glossing over' the theoretical component of vocational knowledge. Echoing Guile (2006), we advocate that the tendency to lose focus on theory has detrimental consequences: (a) students may not readily grasp the relationship between theoretical and practical forms of knowledge, as they do not understand the different internal structuring, contents and purposes of these forms of knowledge; and (b) students may not readily identify the contribution of each form of knowledge to workplace practice, thus continuing to conceive of theory and practice as belonging to non-reconcilable worlds.

Having reviewed the main findings and their plausible interpretations, we now discuss two limitations. One practical limitation of this report concerns the space restriction, which imposed a focus on part of the broader findings and analyses. A second limitation resides in the generalisability of our conclusions beyond the context of this particular study. We suggest that our conclusions are tenable in any context in which professionals are knowledge workers and in which a constructive tension prevails. In other words, we argue that our conceptualisations are valid in contexts in which there is no consensus on the question about how far one should go in reasoning, in which the 'need-to-know versus nice-to-know debate' remains open and in which the within-integration and between-integration perspectives co-exist. We acknowledge that contextual differences can be expected at the level of pedagogical approaches in the workplace and, therefore, we suggest that there is an opportunity for continuing research in different fields and cultures in order to shed more light on the issue of generalisability.

Beyond these limitations, this study has several implications. In addition to raising new questions and generating hypotheses, we have contributed to the operationalisation of the ILTP. This is a step forward for further research on integration and expertise development. For practitioners at schools and in workplaces, this study raises awareness of perspectives on integration, as well as on specific characteristics concerning the process and outcome of integrative learning. Furthermore, the positioning observed along each dimension invites practitioners to consider (or reconsider) which positioning they choose to aim for. In conclusion, this study has coined a definition of the ITLP construct that, we contend, contributes to clarifying the concept of integrative learning. This definition reflects co-existing perspectives on integration and advances descriptive dimensions for both the integrative learning process and integrated knowledge as the outcome. With this, we have provided a basis for reflection, as well as new tools for continuing research.

## Notes

Compliance with Ethical Standards.

Conflict of Interest: The authors declare that they have no conflict of interest.

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