Chapter 16
Competence Domains and Vocational-Professional Education in Germany

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16.1 Introduction

Discussing work-related competence issues in Germany has to take into account the different facets of the underlying 'collective skill formation regime' (cf. Busemeyer and Trampusch 2012). That means to realize the common strong interrelations and commitment of the so-called four tables – the Federal Government, the State Ministries, the Employers' Associations and the Trade Unions – but also their own logic, organization, arrangements and legal regulation.

Therefore, we, firstly, start with the presentation of basic context factors and cornerstones of German vocational education and training (VET) highlighting the inclusive and supportive character of VET in Germany, which safeguards poor achievers and drop outs but also challenges talents. Secondly, we trace some main historical roots of German VET. For the first phase (installation of VET), we describe the tension between general and vocational education as well as the installation of VET by institutions and law. The intention was to safeguard economy with solid qualified (low and medium/high skilled) workers and employees, but simultaneously to educate young people for enabling them to participate within active citizenship. For the second phase (the interpretation of curricula for VET), we focus on how the multiple stakeholders ('tables') in VET collectively engage for negotiating goals and required competence domains and levels of the various apprenticeship programmes. The actors are committed on solving complex authentic work problems balancing job-related and educational goals. Within the third phase (developing

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instructional means for VET), we highlight a huge research initiative on exploring and optimizing teaching and learning processes in vocational education and training. In phase four (developing means of assessment in VET), we discuss the necessity of improving formative and summative assessments in VET for getting insight into efficiency and effectivity of VET endeavours. Thirdly, we introduce a feasibility study – promoted by the German Ministry of Economy and Labour – for running a VET-PISA monitoring VET and, therefore, enabling international comparisons. Fourthly, the ASCOT Initiative (Assessment of Technology-Based Competence in Vocational Education and Training) aiming at development of instruments for modelling and measuring decisive VET competence in engineering, health and business is presented. An example on intrapreneurship competence for commercial education is given. The conclusion (fifthly/finally) wraps up central issues and gives a short outlook.

16.2 Cornerstones of German Vocational Education

Discussion of work-related competence issues for Germany must take into account its system and organization of vocational-professional education and training. Busemeyer and Trampusch (2012) characterize it as a 'collective skill formation regime', which emphasizes the common strong commitment of the so-called four tables: the Federal Government, the State Ministries, the Employers' Associations and the Trade Unions. The basis for this commitment and the common endeavour is regulated on the basis of the *Berufsbildungsgesetz* (Federal Law on VET 1969) by the so-called *Gemeinsames Ergebnisprotokoll* of 1972 (Common Protocol of Negotiations; KMK 1972). According to this common protocol, negotiation processes between these four stakeholders ('tables') of vocational-professional education are standardized, e.g. for identifying of and coping with upcoming (mainly economic or labour market driven) needs to reform, but also for installing a new *Beruf* covering a new and/or a changed bundle of job activities and setting up a corresponding apprenticeship of 2 or 3 years and for running bargaining procedures on goals, content, time, organization, etc. for the training companies and the vocational schools up to the political processes of acceptance. These processes need time – at least 1 year, but often also longer depending on the interest especially of employers and trade unions. In Germany, it is regulated by collective wage agreements that ensure apprentices after their apprenticeship have a guaranteed wage if they enter the economical or technical field to which their apprenticeship is related. This procedure is valid for about 330 so-called acknowledged apprenticeships in industry, crafts and commerce (the number changes slightly with regard to actual political decisions to open or to close an apprenticeship). Beside that there are about 100 training tracks in the social and health sectors. All decisions are published by the Federal Government together with the curricula for the vocational schools (1–2 days a week) and training regulations for the companies (4–3 days a week). Additionally, all companies running apprenticeship programmes have to be

officially acknowledged before they are allowed to provide vocational training within an acknowledged apprenticeship. This acknowledgement certificate ensures that the apprentices will have the necessary learning and development opportunities to reach the negotiated and fixed curricular goals for a particular apprenticeship. The quality of realized learning processes and outputs within the apprenticeship is monitored: the undertaken learning and working processes within the companies are visualized and documented by the weekly diary each apprentice has to write and present to the Chambers of Commerce or Chambers of Handicraft. The vocational schools balance the various practical workplace experiences (across the different industries, firm sizes, etc.) and link them to theoretical concepts, close gaps in general education (Maths, German, English), run critical reflections and support personal development (incl. work/adult identities). On both sides, highly educated trainers and vocational teachers are employed. The companies only get an acknowledgement to run an official VET when they additionally involve a trainer who has obtained an *Ausbildereignungsprüfung* (trainer certificate of the Chambers of Commerce). The examination as *Meister* in the fields of handicraft (with the career: *Lehrling* (apprentice), *Geselle* (journeyman) and *Meister* (master)) includes the right to train apprentices. Teachers of vocational schools possess a Master certificate of a university study programme, a 1-year internship in industry at different real workplaces and between 18 months and 2 years *Referendariat* (internship in vocational schools) with a final state examination. The education of vocational teachers corresponds to that for the secondary school level (*Gymnasium*/high school level). Their salary corresponds to that of all German civil servants on the highest level – that means University Master degree plus 2 years internship with a final state examination. This is also valid for judges at lower courts, attorneys and leading positions in the governmental institutions (*Ratslaufbahn* = counsellor career). The final apprenticeship examination (written, oral, practical) is externally driven by the Chambers of Commerce or Chambers of Handicraft (and *not* by the vocational schools or firms), benchmarked against the negotiated curriculum as the external evaluation criterion.

In Germany, the compulsory school attendance is 9 years (as education is not a Federal issue, there are some differences across the 16 states). Everyone who does not follow the general education track to the *Gymnasium* (3 years of high school) must undergo a 2–3 years apprenticeship to fulfil their school attendance. In cases of limited apprenticeships, there are public substitutional offers for youth (cf. contributions in Zeitschrift für Berufs- und Wirtschaftspädagogik (2014), 110, Vol. 2; Zeitschrift für Unterrichtswissenschaft (2014), Vol. 3).

The main idea is clear: The German vocational education system tries to pick up all youngsters independently of their prior knowledge or of the level at which they left general education. Through different learning locations (workplace, vocational schools, transitional learning opportunities, etc.), young people have the possibility to enhance their general education or close particular gaps and acquire basic occupational knowledge, skills and abilities. They get also counselling for their choice of *Beruf* as well as support for their applications on the labour market. By monitoring the apprenticeship process and evaluating the output against the prior negotiated

curriculum, the labour market gets a highly qualified workforce and can pay a corresponding fixed wage. The different acknowledged apprenticeships (covering a broad bundle of about 30,000 adult jobs) offer flexibility for individuals to change workplaces within or between firms and industries, while assuring wage levels. Thus, young people shift into financial independence and can take care of their own but also get integrated into an adult working community and supported in developing their work/adult identity which is relevant for social and political participation. In various vocational programmes, they can acquire preconditions for getting an additional opportunity to continue their general education and to start a tertiary career (the so-called 'permeability' of the system).

Such a complex 'collective skill formation regime' – of course – also has to deal with lots of tensions arising from different aims and to cope with high heterogeneity of students, stakeholder perspectives and contextual conditions, as well as with political decisions and market developments. For example, what knowledge, skills and attitudes should be taught (job specific, vocational subject specific, cross-occupational or generic)? To what extent should job-, company- or occupation-specific skills and/or abilities be taught? By which instructional means and at which locations should the curricular aims be reached (e.g. practical skills just by learning on the job and theoretical concepts in vocational schools)? Which instructional and learning theory is most efficient and effective for acquiring particular skills? Which kind of assessment should be run within the formative learning/working processes and within the summative final examination of the Chambers of Commerce (e.g. more by multiple-choice tests, open-ended questions, simulated negotiations with customers, but also the question by which evidence the prescribed curricular aims are counted as achieved is currently not sufficiently solved)?

16.3 Historical Considerations on Competence Development in Germany

The development of the German VET system in the last decades shall be ideally illustrated by four phases which are overlapping: The first phase was minted by the institutionalism of the system (until about 1972). A second phase is heavily influenced by needs of the workplaces – forced by the 'megatrends' which increased the complexity of technical and business processes. This led to a reformulation of the goals for the school curricula and training regulations under the headings *Lernfeldorientierung* and *Handlungsorientierung*. Working with the new goals urged in a third phase the development of instructional processes to reach and foster them. New complex teaching-learning arrangements/environments supported learning processes in school and at the workplace. To monitor the effects of these more complex goals and instructional processes made in the fourth phase, it is necessary to develop new ways of measurement which correspond to the complexity of goals

and instruction: the curriculum-instruction-assessment triad which consequently led also to plans to run a large-scale assessment for VET.

16.3.1 Phase 1: Installation of VET

The origins of this strong 'regime' were in the 1960s. Before, Germany had a multitude of measures and procedures which led to very disjointed outcomes – derived from the Middle Ages. The rapid technological changes as well as those of the internationalization of economic processes (later classified as 'megatrends': Buttler 1992; 2009) caused heavy political doubts whether the German economy with its backlog of VET would be able to react adequately to the increasing demand for a qualified workforce. Especially, the broad documentation by three volumes full of practical examples in the journal STERN (one example is Lutz et al. 1965) influenced the public opinion to come to new regulations for the fields of VET. This process was accompanied at the same time by educational approaches to overcome the segmentation of general academic education and vocational education which formed a nearly unnavigable border. The discussion was heavily influenced by ideas of Wilhelm von Humboldt (cf. Blankertz 1963) and Chomsky (1968, who based his considerations remarkably on Humboldt's philosophy of language), but also by the work of Habermas (1981). The argumentation led to the use of the concept of competence. Roth (1971) and later Reetz (1999) distinguished between self-competence, cognitive competence, functional competence and social competence (cf. Baethge et al. 2006). This broad concept with its competence domains and structure has until now dominated the German discussion – at least in the fields of VET but also in areas of work psychology (cf. Sonntag and Stegmaier 2007). These days they get further operationalized for assessment purposes.

It has to be pointed out that the four competence domains cannot be explicitly separated. For example, knowledge is not limited to the domain of cognitive competence, and different kinds of knowledge are applied in functional and social contexts as well; knowledge is used for performing theoretical occupation-related tasks utilizing tools, equipment and technical resources and in interactions with others; acquisitions and applications of knowledge are governed by motives and attitudes and by processes of reflection and meta-cognition.

As the authors of the feasibility study for a PISA-VET (Baethge et al. 2006) were aware of the multitude of proposals to define the competence concept with its facets on the national as well as international markets, they discuss in detail the different approaches (p. 13–58). Goal was to identify possible advantages and disadvantages of the proposals with regard to the dimensions of stringent modelling and precise measurement. The authors come to the decision – as result of their critical analyses – that the four competence domains by the anthropology-based educational-philosophical concept of Roth and Reetz in the shape of an empirical research concept (p. 45) might provide a plausible first basis to run an international large-scale assessment. The international curriculum conference within the preparation of

a feasibility study for mounting a VET-PISA also emphasized this holistic view and defined the aims of competence domains of vocational-professional education and training as:

1. The development of individual occupational adjustment from an individual user's point of view, taking self-regulation and autonomy into consideration
2. The safe guarding of human resources in a society
3. The warranty of social share and equal opportunities (Baethge et al. 2006, p. 11)

That this broad understanding of VET and the corresponding interpretation of vocational-professional competence were getting through in Germany over the last decades and that the VET regime could reduce the predominance of academic education were a result of different movements. Roth with his educational philosophy (1971) was the leading figure in the German Educational Council which defined in a new way the goals of the German Educational System and could, thereby, bring in his conviction into the official papers (especially: *Deutscher Bildungsrat* 1974). In parallel, there were efforts to formalize and legitimate the role of VET within the whole German Educational System. One was the trial to modernize the system by rearranging the relationship of academic and vocational education: that both together stood for German secondary education (after the 9th year of compulsory schooling). Blankertz and Lempert as responsible authors wrote a statement for the *Deutscher Ausschuss für das Erziehungs- und Bildungswesen* (German Committee for the Reform of the Educational System) that criticized the neglect of VET (*Gutachten über das berufliche Ausbildungs- und Schulwesen* 1966), which influenced the political discussion and led to the enhancement of VET. At the same time, a political decision was taken with regard to the foundation of a central research institute on VET. Blankertz and colleagues delivered an expertise which led to the installation of the *Bundesinstitut für Berufsbildung* (BiBB) in 1970 (Blankertz et al. 1966). In 1969, the first Federal Law on VET was edited. The *Gemeinsames Ergebnisprotokoll* was voted through this law. Founded in 1970, the BiBB (Federal Institute for Vocational Education and Training) aims at identifying future tasks of vocational education and training, promoting innovation in national and international vocational education and training and developing new, practice-oriented solutions for initial and continuing vocational education and training for the worksite. It is supervised on points of law concerning its administrative activities by the Federal Ministry of Education and Research. Its present statutory basis is the Vocational Training Act (*Berufsbildungsgesetz*) of 23 March 2005 (a renewal of the Law of 1969) which outlines the Institute's duties. These are currently, e.g. analysing structural developments in the training place market and in continuing education and training, observing and studying initial and continuing training practice in enterprises, testing new methods in the initial and continuing education and training field, identifying future skills requirements through early detection, developing and updating initial and continuing training occupations, supporting in-company vocational training practice with modern training materials and training media, developing concepts for qualifying company trainers and conducting international comparative research on vocational education and training (see the BiBB website: http://www.bibb.de/en/1420.htm).

16.3.2 Phase 2: Interpretation of VET Competence Domains (Curriculum)

In the following years, the competence interpretation process was still valid for Germany. Various curriculum projects were established to develop curriculum theories (Robinsohn 1967; Frey et al. 1975; Hameyer et al. 1983), to investigate empirically VET teaching and learning processes as well as teacher-learner interactions, etc. (cf. Achtenhagen and Tramm 1983). The results of these endeavours show that the content was highly abstract, mainly cognitive related on a relatively low level and assessed by batteries of multiple-choice tasks testing abstract knowledge. The discussion on VET competence domains and levels got a stimulus by the introduction of the concept of *Lernfeldorientierung* (orientation on complex vocational-professional activities in larger learning and training areas) which should help to develop action-oriented competence (*Handlungskompetenz*) (KMK 1996). It emphasizes the fact that VET and vocational-professional competence shall focus on the complexity and authenticity of tasks to be fulfilled at the workplaces. Coping with isolated functions of a motor should not stay in the centre of teaching and learning within an automobile apprenticeship but in the contrary: the functioning of a motor as a whole should be the focus. This principle led to reformulations of the VET school curricula as well as of the training regulations. The German VET skill regime – demonstrated by the *Gemeinsames Ergebnisprotokoll* – established this renewal by an agreement of all four 'tables'. These new ideas were accompanied by many research trails ('Modellversuche') which were in sum not very effective, especially for their lack of psychometric methods.

16.3.3 Phase 3: Instructional Means for Teaching VET Competence (Instruction)

Subsequently, German research in the fields of vocational-professional education and training followed this comprehensive understanding of competence and tried to work it out in more detail. Under the scope of *Lernfeldorientierung* and *Handlungskompetenz*, different means were developed to enrich the teaching-training and learning-working situations within the different apprenticeships. The aim was to model complex teaching-learning environments by which comprehensive vocational-professional actions could be taught and trained, but also evaluated (cf. Achtenhagen and John 1992; Achtenhagen 2002). This task urged new ways to model such complex situations in an authentic way (Achtenhagen 2001; Achtenhagen and Weber 2003; Janesick 2006). Weber (2013), here, introduced the necessity also to take into account different system levels (micro, meso, macro) and locations of workplace learning (VET schools, firms or other institutions). Another point has been to operationalize the concept of 'knowledge' with regard to the needs of the workplace by introducing in addition to declarative and functional knowledge the

dimension of strategic knowledge (cf. Achtenhagen 2004). This dimension is important for successful working at the workplaces as it deals with weighing detailed information (as declarative and functional knowledge) concerning intended main effects and given possible unintended side effects to come to adequate and effective decisions. The approaches stand for trials against rote learning. For example, see the concept mapping approach on network-like thinking in business education (Weber 1994) or the intervention study for enhancing intercultural competence as a necessary requirement in the internationalization processes on the market (Weber 2005).

These different approaches were supported by a focus programme of the German Research Council: *Lehr-Lern-Prozesse in der kaufmännischen Erstausbildung* (teaching-learning processes in initial commercial education and training) (1994–2000) (Beck 2002; Beck and Heid 1996; Beck and Krumm 2001) – which referred to the recommendations of a critical overview report on the state of the art of German VET research (DFG 1990). Here in close cooperation of Human Resource Education (*Wirtschaftspädagogik*) with Psychology, a well-diversified bundle of research projects was run which helped to further operationalize the competence concept as well as to evaluate different instructional measures urged by these new curricular goals.

16.3.4 Phase 4: Developing Means for Evaluating VET Competence (Assessment)

For developing the efficiency and effectiveness of VET training courses or programmes, it was necessary to put emphasis on evaluation activities (cf. Weber 1994) as assessment work was underdeveloped in German VET research – compared to psychological approaches. Evaluation was done more with the focus on individual aims of specific courses/programmes and single constructs like, e.g. knowledge, network-like thinking or motivation and less under a systematic view on the basis of a particular 'competence' concept or under an overarching structural comparative view.

The endeavour to develop VET and VET assessments more systematically was supported by the results of the PISA studies in the area of compulsory education which brought for the German field of VET research at least three main impetus: (a) they showed for the area of compulsory education a relatively bad achievement; (b) the format of the test items was not suitable for measuring VET competence as they did not allow to mirror workplace actions and activities; and (c) they showed the advantage of new statistical approaches, especially item response theory. (Although these methods have been proposed for a long time, e.g. by Achtenhagen and Tramm (1983), they had not been executed in the field of VET until the PISA wave.) A German Federal Initiative developed – as an answer to the bad PISA results – national standards for compulsory academic education (Klieme et al. 2003), but neglected the vocational-professional field.

These topics showed the necessity to develop further the competence concept for VET together with a reform of curricula, training regulations, instruction and assessment tools. As such profound reform needs a lot of conviction and time, a research group proposed to treat these necessities by generating a feasibility study on a VET-PISA as a frame to also bring in exemplarily an articulated competence concept for VET (Baethge et al. 2006). This strategy should serve as a motor to rethink and revise the overarching competence domain in VET, at least in Germany. This proposal was accepted and promoted by the German Federal Ministry of Economy and Labour.

The plan is to run a PISA study for professional fields. The needs were also supported by analyses of international concepts of VET within the European COST-Action A11 (Achtenhagen et al. 1995; Achtenhagen and Thang 2002; Achtenhagen and Weber 2008); the survey of international vocational education and training within the Fourth Handbook of Research on Teaching of the American Educational Research Association (AERA) (Achtenhagen and Grubb 2001); and the OECD-driven DESECO approach (Rychen and Salganik 2001) defining especially cross-curricular competence and key competence as central goals by domains of 'acting autonomously', 'using tools interactively' and 'joining and functioning in socially heterogeneous groups' – a study with explicit connections to Roth's concept of competence and Weinert's (2001) widely accepted competence definition, as well as from comparative approaches to regulate the European qualification systems by the European Qualification Framework (EQF) and the European credit transfer system for vocational education and training (ECVET) (cf. Cedefop 2014). Central goals, here, are to increase transparency of VET in Europe and facilitate comparability of vocational competence.

One major problem of most of these proposals and schemata for comparison has been the fact that there was a lack of precise measurement – especially taking into account the competence concept. A study of Fulst-Bleil and Ebner (2005), for example, demonstrates by comparison of the English-Welsh level of 'GNVQ Advance Business' and the German level of *Industriekaufmann* (industrial clerk) that the German apprenticeship should have been classified higher or at least equal to the English-Welsh endeavour, although according to the English-Welsh approach its course was ranked higher. Recent examples demonstrate that neither EQF nor ECVET provides a basis to promote and guard political or practical decisions. In Germany, this means, for example, the inability to define and coordinate consensually and adequately the levels of the gymnasium-leaving certificate (*Abitur*) and of apprenticeships.

16.4 The VET-PISA Concept

Mainly two facts led to the development of a VET-PISA concept:

1. Although the PISA action caused in Germany a lot of attention and political reaction for the general academic sector, it was clear that the item patterns used did not work in the vocational and occupational fields. They were/are too simple to model and measure workplace affordances.
2. The experiences won with the complex reformulation of goals, instruction and assessment strengthened the suggestion to develop plans for a PISA study which would be adequate for VET. Consequently, a concept was developed as feasibility study (Baethge et al. 2006), first cross-national studies (Baethge and Arends 2009) and first assessments (Achtenhagen and Winther 2009; Nickolaus et al. 2009) were run. As a consequence the German Federal Ministry of Education and Research started the ASCOT Initiative to develop further modelling and measuring competence in central VET domains.

16.5 Feasibility Study

As a consequence of these manifold facts and observations, Baethge et al. (2006) developed the concept of a large-scale assessment of VET following the TIMSS and PISA approaches for the compulsory school system. The clear purpose was to operationalize, to model and to measure the competencies necessary to fulfil tasks in the workplace and, thus, to provide robust results to inform the setting of levels for VET programmes (cf. also Weber 2013) – which also could help define valid and reliable levels of the EQF and ECVET. It was central to bring together individual capabilities and workplace skill requirements under the heading of competence – thereby avoiding aspects of a reduced adaptation of VET to the needs of workplaces. The group (1) refers to the international discussion (cf. Malloch et al. 2011; Mulder 2011, 2005; Nijhof and Streumer 1998; Rauner and Maclean 2008; Rychen and Salganik 2003; and also more empirical oriented: Spencer and Spencer 1993; Peterson et al. 1999, 2001; Oser et al. 2009; Winterton 2009; Scott and Reynolds 2010; Griffin et al. 2012). A second step (2) is to keep and to develop further a comprehensive understanding of VET and correspondingly of competence as it is founded by the educational-philosophical tradition (cf. Roth 1971; Reetz 1999; Habermas 1981; see also summarizing Seeber and Nickolaus 2010; Seeber et al. 2010; Zlatkin-Troitschanskaia and Seidel 2011). This includes (3) the reflection of goals and content of VET for formulating the items as workplace-related authentic tasks with their inherent complexity, the consideration of how complex the instructional methods are at the workplace and in the vocational schools – or should be – and the formulation of the items themselves that they show a complexity which corresponds to the goals, experiences and authentic workplace tasks and enables to show evidence for the intended achieved ability. The concept of the curriculum-instruction-assessment triad (Pellegrino 2010; Achtenhagen 2012) covers this approach of comparable complexity of goals, learning/working situations and items for assessment and helps, therefore, to overcome the neglect of the importance of

test procedures in the field of VET and to measure competence in a sense-making, psychometrically supported way.

Comparable to the triad approach, considerations on the alignment of goals, instruction and evaluation are given. As a prominent example for university teaching and learning, see Briggs and Tang (2011). They give excellent hints for practitioners, but do not deliver an overarching theory for necessary curricular and instructional decisions or for the choice (and complexity) of assessment. This corresponds to the fact that they avoid a philosophy-driven reasoning on their approach – points that are included in the curriculum-instruction-assessment triad.

From a policy perspective, such complex assessment procedures might improve an evidence-based monitoring and steering of VET particularly with regard to (a) the interrelationship among individual/biographical characteristics, educational programmes and competence development; (b) the link between the outcomes of comparative measurements and institutional capacity of VET systems (revealing strengths and weaknesses of different VET organizations in different countries); (c) the interrelationship between certificates of final examinations and the competence assessed; and (d) the classification of different examinations in VET in international systems of classification (e.g. ISCED; EQF) to improve certification methods at the European level.

16.6 Identifying Cross-National Overlaps of VET Competence

To measure and compare performance of national VET systems – including Germany – regarding the goals of VET, the necessary competence levels and their structural relationship with institutional factors and input criteria, at least three methodological problems had to be solved:

(a) With regard to the differences in job-classification schemata in the participating countries, how can occupational fields and work activities be identified and internationally related to each other?
(b) How can vocational competence be measured and compared?
(c) How can the relevant micro- and macrostructural conditions of the VET systems in different countries be analysed and compared?

These questions were formulated by experts from 18 countries (including the USA, Australia and also Cedefop).

The basic ideas were tested through feasibility studies in eight European countries with N = 349 experts in the fields of technology, health and commerce (Baethge and Arends 2009). In the field of business and commerce, run by Breuer et al. (2009), 70 experts from six countries undertook the task by referring to ISCED 3B, ILO 08-33 and O*NET (job zone 3 or 4; SVP 6.0 to < 8.0). All six countries agreed that nine occupational tasks were representative for the fields of business and

commerce. The tasks were judged by the countries on their relevance. The judgments of the relevance of occupational tasks show for the three highest ranked tasks the following structure (cf. Breuer et al. 2009, p. 74):

- Prepare invoices, reports, memos, letters, financial statements and other documents.
- Respond to customers'/suppliers' inquiries about order status, changes and cancellations.
- Review files, records and other documents to obtain information to respond to requests.

16.7 Creating First Assessments

To measure the competence to fulfil such occupational tasks, it was necessary by a next step to develop test items which could mirror the complexity and difficulty of workplace tasks. Within a following project, Achtenhagen and Winther (2009; cf. also Winther 2010; Achtenhagen and Winther 2014) used the results of the feasibility study and the concept of complex teaching-learning environments for the fields of business and commerce to model a computer-based virtual enterprise and its workplaces in accordance with a real firm and constructed for that virtual enterprise a comprehensive data packet with all means and data necessary to follow realistic business processes (parallelly, there was a second study in the fields of car mechatronics: Nickolaus et al. 2009). Data included, for example, balances, cost accounting and prices for different products. There were also descriptions of workplaces of different departments. Because business processes are related mainly to the handling of information and data, it is important, for maintaining authenticity, to transform them in such a way that they are realistic. The tasks to handle the information and data are, therefore, the same as in real firms. This is the basis for testing workplace learning and corresponding competence: using workplaces of a virtual enterprise objectively, reliably and validly. Experts of the real firms also checked all the tasks to be fulfilled in the virtual enterprise with regard to their typicality. Agreement was unanimous.

The tasks were converted into a web-based format. The technology-based assessment focuses on the meaning, range and level of specific work-related skills and abilities in the occupational fields of business and commerce. To provide authenticity, content validity and practical adaptability during the test, the assessment is grounded on a real company as a benchmark. The modelling requirements are strict. First, a transparent method of production together with a short part list of production items is necessary to clarify the company's objects also for apprentices/employees trained in other firms. Second, well-known products are incorporated to guarantee identifying marks during the test. Achtenhagen and Winther (2009) installed a virtual company called ALUSIM Ltd. which fabricates aluminium packages to act as the context for the assessment. The company's products are beverage

cans (Coca-Cola), cosmetics (Nivea) and food-grade packaging. Authentic parameters of modelling were used, including company history and reporting (e.g. balance sheet, profit and loss statements, cash-flow analyses). Third, authentic large volume production and its corresponding costs were included, together with real-world customers and suppliers. An important criterion for authenticity and, therefore, for the measurement of workplace-related competence was to embed the tasks sequentially in processes to avoid an unrealistic static handling of isolated tasks.

The virtual enterprise was constructed with workplace tasks of three departments according to those identified by the international feasibility study: sales department (three sequences of tasks), purchasing department (four sequences) and production planning department (two sequences). This also included the development of different technology-based tools such as story boards of authentic business processes; applications of integrated ERP systems, including customer and supplier lists, in-depth analyses of the designed company; and so on.

All these products and modelling steps are necessary to stimulate performance in authentic vocational situations and work processes as key elements of competence measurement. In other words, a simulation of real-world conditions ensures measurement of authentic abilities without bringing those being tested into such real-world situations. Therefore, the business simulation contains complete business processes. This focus guarantees interpretability of test results. The simulation ensures a content-related and cognition-based characterization of the test environment and provides a valid description of personal abilities and item difficulties with regard to concrete test challenges, thereby permitting a psychometric modelling approach.

All domain-specific challenges are video based and refer to a complete sequence of tasks (e.g. work processes). The test subjects navigate through the tasks using an interactive desktop which encompasses all documents, ERP systems, filings and helping tools to test the ability to cope efficiently and effectively with the tasks and to solve them as a basis for the measurement of competence.

Starting the video opens the domain-specific challenge. The test subjects watch a dialogue between a trainee and an employee, which contains useful information and a reference to solving the process. However, different work processes structure each challenge. The sales challenge, for example, starts with two steps. First, the test subjects must enter customer data into the ERP system. Therefore, they must review all relevant customer information, the ERP requirements and the production process. In a second step, another test situation, the trainee receives information from the production department that the sale cannot be closed on usual terms. The trainee must manage that situation by contacting the customer. The outlined work process demands a deep understanding of sale records, economic conditions, customer buying patterns and sensitivities. The test subject must anticipate the entire production process to find the new delivery date, make the right decision and inform the customer correctly and (to prompt a long-term relationship with the customer) also politely, which is part of the corresponding test item. Thus, both work processes refer to different complexity levels.

Achtenhagen and Winther (2009) assigned all different actions to be fulfilled within this virtual workplace to test items. They coded the quality of the corresponding actions per item (as 0/1 or graduated). The test consists of 34 items related to business actions and 26 items related to the comprehension of business processes. They run the test with 264 test subjects (third year apprenticeship industrial clerks) in 15 classrooms in seven commercial schools in three German States. The subjects were between 20 and 23 years old.

Achtenhagen and Winther (2009) analysed their data by applying a multidimensional random coefficient-multinomial logit model out of the family of item response theory (IRT) for competence measurement (Adams et al. 1997) using the software ConQuest (Wu et al. 2007). The results show that the model fits the empirical data. All values for validity and reliability of the test results are very good.

By this procedure, they scaled up the items according to their difficulty and the subjects' abilities simultaneously on the same logit scale. This is a great advantage as in classical test theory, the analyses are just run by summing up the subjects' total test scores. That means individuals with the same total test score are assigned to the same competence level irrespective of whether one has solved the more easy tasks and the other the more difficult ones.

Furthermore, Achtenhagen and Winther (2009) could identify by their analyses two competence dimensions: 'action-based competence' and 'understanding-based competence'. Test subjects showed a higher competence in solving the 'action-based' test tasks than solving the more cognitively driven 'understanding-based' tasks at the end of their 3 years apprenticeship.

16.8 The ASCOT Initiative as a Nation-Wide Pilot

Although VET, in research and practice, was highly inspired by these first VET-PISA endeavours, the initiatives were hindered for some years in Germany for political reasons: one of the four 'tables' feared a loss of influence. But the needs for reform were great, so a Federal Research Initiative was started on the basis of the given research results: ASCOT (Technology-Based Competence Development in Vocational Education and Training; http://ascot-vet.net/) for the areas business and commerce, technology and health and care. For the business and commerce sector, four projects were run: two following and enlarging the ALUSIM approach for industrial clerks (Winther, University of Paderborn) and apprentices for transport and logistics (Seeber, University of Göttingen), one for problem-solving in controlling (Seifried, University of Mannheim; Wuttke, University of Frankfurt; Sembill and Rausch, University of Bamberg; Wolf, University of Bremen) (together with a focus on emotion and motivation; Sembill et al. 2013) and one for intrapreneurship (Weber et al. 2014a, b).

With regard to the increasing interest on the European Labour Market in entrepreneurial and intrapreneurial mindsets for mastering the tremendous competition in various markets (Parent-Thirion et al. 2008), this fourth project deals with the

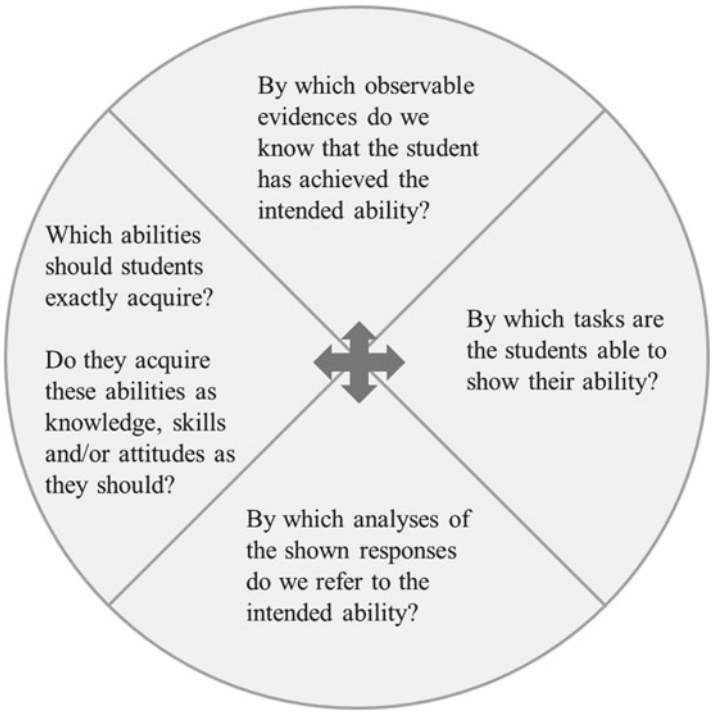

Fig. 16.1 Central categories of an evidence-centred assessment design (Source: Own graph according to Pellegrino et al. 2014)

modelling and measurement of intrapreneurship competence as a central goal in commercial curricula (e.g. industrial clerks) (Weber et al. 2014a, b).

The modelling and measurement processes of the research group around Weber are based on the 'Evidence-Centred Design [ECD]' approach of the Educational Testing Service [ETS] in Princeton (Mislevy and Haertel 2006; Mislevy and Riconscente 2006; Pellegrino et al. 2014), considering the four building blocks of Wilson (2005) as well as those of Shavelson (2012) (Fig. 16.1):

According to these suggestions, Weber and colleagues (see Weber et al. 2014a, b)

- *Run an extensive domain analysis*
  For gathering substantive information on the domain: asking what is the epistemology of the knowledge under investigation and corresponding implications for learning, teaching and assessment
- *Conduct a domain modelling*
  To express the assessment goal in narrative form based on the domain analyses
- *Build a conceptual assessment framework*
  To express the assessment goal in structures and specifications for tasks and tests, evaluation procedures and measurement models

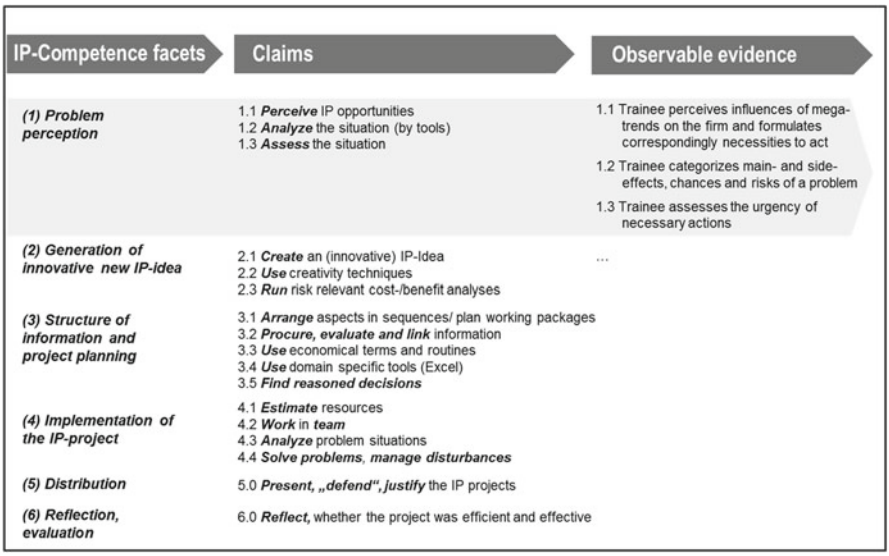

Fig. 16.2 Competence facets, claims and evidences (Source: Own graph according to Pellegrino et al. 2014; Weber et al. 2014a)

- *Imply the assessment*
  To implement the assessment, including presentation-ready tasks and calibrated measurement models
- *Deliver the assessment*
  To coordinate interactions of students and tasks, scoring and reporting

According to the results of their domain analyses, the research group defined 'intrapreneurship' in accordance with Perlman et al. (1988) as a process. Within such an intrapreneurship process, a person meets his or her needs for autonomy, invention, management and completion of projects within a complex bureaucracy. Furthermore, intrapreneurship is perceived as a process by which new ventures, products and projects are developed and implemented in organizations.

The group of Weber conceptualized intrapreneurship behaviour on the basis of their extensive domain analyses as 'innovative behaviour' of an individual (Rupprecht et al. 2011). Thus, an individual is seen as a competent 'intrapreneur' when he/she is able to activate and use the following six intrapreneurial competence (IP) facets while solving complex, authentic intrapreneurial tasks (Fig. 16.2). These competence facets were further operationalized with regard to claims which visualize the facets more in detail. It is also shown how evidences for these claims of a competence facet can be empirically observed.

As intrapreneurship is part of the official curriculum in schools and at workplaces, Weber and colleagues tried to get insight into the current intrapreneurial behaviour of trainees at the workplace by their domain analyses. The group was able to collect a randomly selected sample of 'final exam reports' of industrial clerks at the end of

their 3 years of apprenticeship for the year 2011/2012 in Upper Bavaria (N = 205). The corresponding Chamber of Industry and Commerce facilitated access. Each report covers about 6 pages and represents an intrapreneurship project run by an individual apprentice at the worksite within his/her training company. The papers varied tremendously with regard to their project themes (e.g. supervising a communication campaign via the social network 'Facebook', invoice management, implementation of an integrated health management process, new regulations for the export into a West-African country). Nevertheless, the documented intrapreneurship activities could be categorized according to the competence model (Fig. 16.2). The apprentices formulated sentences which are coded as units.

A unit like '… as this division is organized by cycle times, for this period 'jumpers' are deployed' was categorized under the IP facet '(4) implementing (IP) projects', and a unit like '…with 5.000 participants especially the table-lottery for the 'Oktoberfest' was very popular …' was aligned to the IP facet '(6) reflection evaluation'. The raters were trained and 45 reports were coded commonly by two raters. The interrater reliability according to Cohen's Kappa = 0.81 could be judged as very high (Fleiss and Cohen 1973).

The data won by the content analysis were additionally coded dichotomously for each individual and each category to be used within an IRT analysis (1 = competence facet/claim used; 0 = competence facet/claim not used). For the calculation, the one-dimensional Rasch model (1PL Model) (Rost 2004) was applied using the software ConQuest (Wu et al. 2007). The model describes the probability distribution of dichotomous answers as dependent variables in relation to the independent variables (ability of the testee and item difficulty). The answers determine the probability by which a testee with a specific ability solves an item with a particular difficulty correctly – the probability by which an apprentice with a specific intrapreneurship competence uses the particular intrapreneurship facet (Wright and Stone 1979, S. 15–17). The relationship of apprentices' skills and item difficulty/used claim is visualized by the Wright Map (see Fig. 16.3).

The individual apprentices are represented by the crosses on the left-hand side of the logit scale (and can be identified individually), and the items/claims (according to Fig. 16.2) are represented by the numbers on the right-hand side of the scale. By that, it is possible to identify the intrapreneurship competence of the individual testee and also the difficulty of the single item/claim. The model works as follows: each apprentice applied the claim(s) which is on the same horizontal line with a probability of 50 %, the claims below this line with a higher probability (as they are easier) and the claims above this line with a lower probability (as they are more difficult). For example, no. 2.1 represents the claim 'create an (innovative) IP-idea' which seems to be rather difficult. No. 3.1 represents the claim 'arrange aspects in sequences/plan working packages' which has a medium difficulty. No. 4.1 represents the claim 'estimate resources' which seems to be very easy.

The fit statistics show very acceptable values. The WLE reliability is 0.7, and the discrimination index for all items is $0.18 < d < 0.70$ (Weber et al. 2015).

The advantage of this procedure is that one gets values to judge the competence of the test subjects with regard to the difficulty of the tasks. Thus, this procedure and

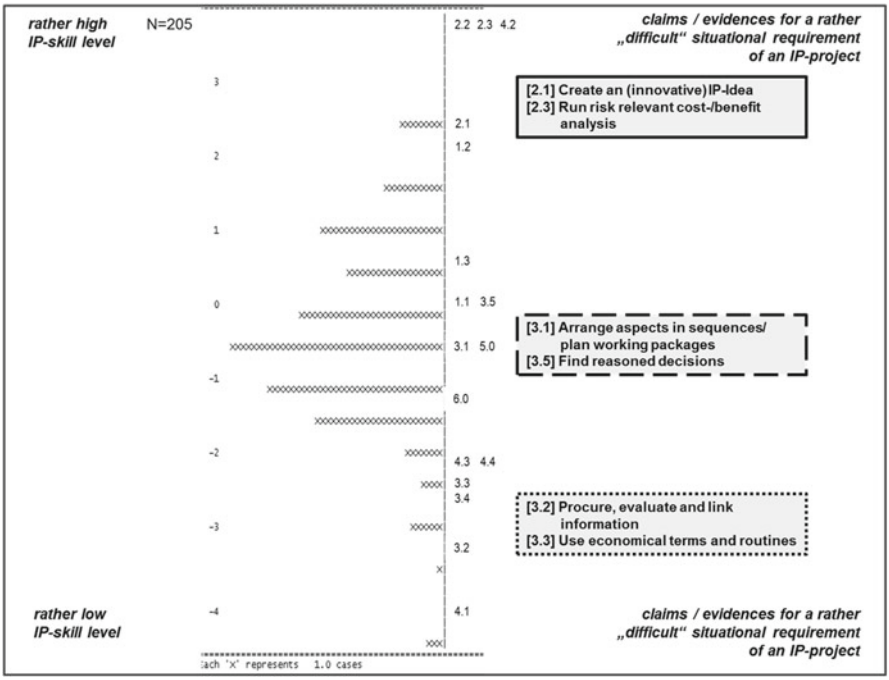

Fig. 16.3 Wright Map – use of facets of intrapreneurship behaviour of industrial clerks (Source: Own graph according to Weber et al. 2015)

its results open new possibilities to enrich the quality of vocational-professional teaching/training and learning/working processes: as it can be seen which content must be taught again or must be presented in another way. This opens new paths to a more efficient and effective workplace learning. The results can also be used for the development of a PISA-VET and give hints for a renewal of a commercial apprenticeship for industrial clerks.

Whereas the IRT scales up competence and difficulties of work tasks for more overarching summative assessment and monitoring (incl. comparative studies), we continue the work on measuring competence for a formative assessment and cognitive diagnostic measurement (CDM) (Helm et al. 2015). The idea is to work out an individual's personal competence profile to identify individual strengths and weaknesses for an individual feedback and enhance vocational-professional learning and development. For this step, explicit cognitive processes used while solving the tasks have been analysed (mainly by running think alouds, expert interviews, etc.) (Bley 2015) and other psychometrical models have to be applied.

16.9 Conclusions

This chapter presents examples for competence domains within vocational-professional education in Germany. Departing from the cornerstones of the 'collective skill formation regime' in Germany, some historical highlights are given: the implementation of VET and the development of VET-oriented skills. One major problem of VET in Germany, but also in all industrialized countries, is to prepare youth for the increased complexity of tasks at the workplaces. The discussion above should have made clear that it is not enough to 'just formulate' desired competence domains. It is necessary (1) to link the competence construct to a theoretical frame (as here, e.g. to the holistic anthropologically based competence concept of Roth (1971) and Reetz (1999) as well as the integrative model of Weinert (2001) and Winterton (2009) and other domain-specific theories and concepts), but also to relate them to the current labour market and corresponding needs (domain analyses, O*NET) – that means structurally (which kind of knowledge, skills and attitudes is relevant) and with regard to the content (accounting, intrapreneurship etc.); (2) to operationalize them further as concrete teachable and learnable claims for an efficient and effective instruction on different sites (school, workplace); and (3) to run formative and summative assessments that are able to secure by evidences whether an individual has acquired the competence or not. For such an assessment, a close alignment between curriculum-instruction-assessment triad is indispensable and prior to a sound model-based psychometric measurement (Embretson 2010).

With regard to a VET-PISA, this alignment within the triad as well as further national and organizational context factors has to be negotiated. But the initiatives and exemplary projects presented here might open new views on a challenging pathway.

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