Competence Development and Assessment in TVET (COMET)

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Theoretical Framework and Empirical Results

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Foreword by Book Series Editor

In the twenty-first century, vocational education is changing increasingly rapidly in response to a move from traditional manufacturing to hi-tech industries, the production of value-added products, and the ever increasing expansion of service and communications industries. Attention is increasingly focusing on meeting the needs of those transitioning from schools to the workforce, or tertiary education, particularly those following a vocational pathway.

The unification of a qualifications system for vocational skills has been a key issue for TVET for sometime. Currently governments in over 100 countries are designing, implementing, or considering national qualification frameworks (NQFs), or are involved with regional qualifications frameworks. Interest in NQFs arises because of the issues of relevance, flexibility, and portability of skills and training, and the effects on employment opportunities. Countries have adopted different approaches to NQFs, but the underlying motives driving the process are usually similar. These include the need to strengthen links between education, training, and the labor market; the need to ease the process of labor mobility across employment sectors, regions, and countries, including lifelong education and training; recognizing prior learning experience and credits; setting standards based on learning outcomes; facilitating quality assurance; and improving the perceived status of TVET.

This book rises to the challenge of developing an international and portable assessment framework, through the use of "Competence Development and Assessment in TVET", referred to as COMET. This is an effort to test for competence diagnostics in vocational education and training, testing the developed methodology in the area of electrical engineering, with extension to other occupations. Vocational education and training is viewed as a complex field that poses high demands on the development of large-scale assessment frameworks, especially for international comparative testing.

The authors describe how vocational education is characterized by a variety of particular circumstances that makes it very difficult to implement an international comparative competence assessment. The number and diversity of occupations do not allow occupations to be grouped in comprehensive competence fields across occupational domains. Previous efforts to overcome this through the adoption of the

concepts of general technological literacy for engineering and technology, and economic literacy for business and administration, were not successful. It is also acknowledged that qualifications are subject to significant change, particularly due to rapidly changing technology and greening economies. The development of occupational profiles and training requirements is a constant challenge.

This book provides a detailed and systematic approach taken in developing and testing the COMET methodology, and as such the authors' contribution to better understanding the world of TVET is gratefully acknowledged.

March 2012

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Preface

The project COMET – "Competence Development and Assessment in TVET" – is an ambitious effort to test a methodology for competence diagnostics in vocational education and training in the course of a study that focuses on two occupational profiles in the domain of electrical engineering and currently is applied to other professions as well. Especially as regards international comparative testing, vocational education and training is viewed as a heterogeneous and complex field that poses high demands on the methodology of large-scale assessment.

First, internationally established professions can be found predominantly in the crafts and healthcare sectors. In industry and commerce, on the other hand, the tendency towards the internationalization of occupational profiles is much weaker. The "World Skills" can be regarded as an indicator of the internationalization of curriculum development. After all the number of occupations that participate in this competition has grown to approximately 50 in the meantime, including modern industrial occupations like mechatronic.

Another obstacle for the establishment of an international comparative competence assessment in the field of vocational education and training are the different national VET systems with their dual, school-based and alternating forms of vocational learning.

From a scientific point of view, one of the assets of the methodology for competence assessment presented in this volume is the fact that it allows to measure not only professional competence (and its development) but also the development of professional identity and the ensuing occupational commitment. The teachers who were involved in the development of the COMET concept are predominantly interested in the methodology under a pedagogical perspective. This interest is met by the evaluation and measurement tools insofar as the latter are particularly suitable for supporting the teachers in the implementation of the syllabi, which are structured on the basis of "learning areas". Therefore, the COMET toolbox can also be used as a didactical and methodological support for the planning of school lessons.

The objective of vocational education is the impartation of professional competence in the sense of the ability to act in a professional context. Therefore, *school-based* types of vocational education are followed by a phase of practical training on

the job, and work placements are usually integrated into the curricula of full-time vocational schools. The *vocational* orientation of the various types of VET is an essential prerequisite for comparative competence assessment in this domain. This requires a competence model that can be used as a basis for the measurement of individual competences and competence development as well as for the evaluation of vocational learning processes.

Professional competences are developed in (dual) vocational education and in the process of cooperation between different learning venues. The professional work experience is of crucial importance for the development of competence and vocational identity. The COMET test results represent the learning and development processes at the two learning venues of dual VET (school and company) and can therefore be used as well for the further development of the cooperation between them.

The detailed analysis of the first project phase is expected to yield information and insights for policy makers and VET practitioners concerning the organization and design of vocational education and training processes in an unprecedented depth. The publication of the theoretical framework is expected to stimulate a more intensive debate about the development of learning methods in the vocational education and training system and to give a powerful impetus towards the transnational development and establishment of a high-performance methodology for VET assessment.

Contents

Introduction: Competence Diagnostics in Vocational Education – What For?

"Competence diagnostics in vocational education – what for?" This question is well justified. If we only focus on the German context, since the early 1970s the BLK pilot programme of the federal and *Länder* governments in Germany has triggered a broad range of innovation processes, which contributed to a nationwide modernization of vocational education. The same is true of pilot programmes in the business sector (*Wirtschaftsmodellversuche*) under the aegis of the Federal Institute for Vocational Education and Training (BIBB), which were concerned with the support of innovation in training in enterprises. The development and implementation of methods of competence assessment as a basis for comparative competence diagnostics has never been a topic of these innovation programmes.

The focus has been on

- The modernization of occupational profiles and curricula
- The replacement of subject-based learning by a concept of learning that is based on vocational learning fields
- The testing of new media
- The improvement of the cooperation between learning venues
- The re-establishment of learning in the work process
- The development and testing of didactical concepts on new technologies as a core topic of vocational education and training programmes
- The testing and dissemination of action- and assignment-oriented learning

The list could be extended. It gives an impressive picture of the diversity of aspects that have to be taken into consideration when the improvement of the quality of vocational education is at stake. The argument that the easy access to the two pilot study programmes has compromised the quality of the projects and consequently of the programmes themselves is both right and wrong. It is right in the sense that the pilot projects soon after their establishment abandoned the concept of (quasi) experimental research and redefined themselves as innovation projects in the sense of action research.

The focus thus shifted from the legitimization of decision-making processes for VET policy and VET administration on the basis of experimental research to the

organization of the interplay of scientific, practical, and administrative competence in "processes of change" with objectives that had to be negotiated in advance. In this innovation paradigm, the VET practitioners become the main actors, the "promoters" of innovation projects. Science and research have an accompanying and supportive role, and this is why the criticism mentioned above is also wrong at the same time. Accordingly the access of practitioners to the pilot programmes should depend on the quality of project ideas and the commitment of applicants rather than on the expertise in writing excellent project proposals. This reminder seems appropriate when it comes to initiatives for developing a large-scale competence research in vocational education because the diversity of paradigms, instruments, and methods for innovations in the VET systems should not get out of sight. They are still oriented towards the definition of good educational objectives, the selection of teaching and learning contents, and the advancement of learning methods and educational programmes.

What, then, is the point of a competence diagnostics for vocational education? The COMET project has two answers to this question. The first of these has been formulated by the teachers involved in the project. Their interest is to have access to a theoretically sound and empirically verified competence model and to corresponding testing methods in order to gain a better insight into the strengths and weaknesses of teaching and training. From this perspective the competence model and the methodology of competence assessment should be applicable as an immediate support for the pedagogical work of teachers.

The second answer is the one that applies as well to PISA and similar projects: a large-scale competence diagnostics as the basis for comparative assessment leads to findings whose importance is increasingly recognized by the governance and support systems of vocational education. Needless to say the new transparency engendered by this process also creates some suspicion on the part of VET practitioners as the quantification of results puts especially those under pressure who perform less well according to the test results. In any case the introduction of a model-based competence assessment generates a great variety of new knowledge on the quality of vocational education, which will be to the benefit of a constructive VET dialogue between all stakeholder groups in vocational education and training. Beliefs, prejudices, and illusions are replaced with sound knowledge on the basis of quantitative data. This facilitates cooperation at all levels of the VET system.

The COMET research team is well aware that there is a certain fascination about the quantitative results, which may prompt one to overestimate the range of the "facts" (see especially Sect. 1.5). The quality of good vocational education depends also on factors that cannot be quantified. It is correct, however, that the COMET methodology for the first time allows for an exact, model-based measurement of core dimensions of VET. Thus a new level of knowledge for the design and implementation of vocational education can be achieved. The discussion and estimation of the range of the data therefore serves also the end to evaluate the relevance of the test results and to draw the "right" conclusions. The depth of the analysis was assessed quite positively by all participants already at the end of the first project phase. From the point of view of educational planning the advantage of the research

findings is their contribution to enhancing the attractiveness of vocational education. They also can help to organize the reintegration into the education system more effectively, especially with regard to the transition from school to vocational education (first threshold) and with regard to the transition from vocational education into the employment system, continuing vocational education and higher education.

In 2007 the German Research Foundation (DFG) approved the establishment of a priority programme titled "Competence Models for the Assessment of Individual Learning Outcomes and the Evaluation of Educational Processes" (cf. Klieme and Leutner 2006). This priority programme aims at the development of competence models as a necessary condition for the coordination between learning objectives and test development as well as for the interpretation of test results against the background of pedagogical theory and educational planning. The research task addressed by the priority programme is crucial for competence diagnostics. Prenzel, Gogolin, and Krüger, in their editorial to a special issue of the *Zeitschrift für Erziehungswissenschaft* on competence assessment, once again emphasize the research needs in competence diagnostics: "What is missing is a model of cognitive, but also of motivational and metacognitive components that are needed to master certain tasks and problems" (Prenzel et al. 2007, 6). The COMET project is an effort to put a theory-based competence model under empirical scrutiny. In terms of vocational pedagogy, COMET aims at the implementation of the concept of learning areas, which was agreed upon by the Conference of Education Ministers in Germany as a basis for a work and business process oriented vocational education, which has the objective to enable trainees "to shape the world of work and the society in the spirit of social acceptability and ecological compatibility" (KMK 1996a, b; cf. Rauner 1988). This explicit statement implicitly holds for a major aim of VET in other countries and structural contexts as well.

This aim implies a paradigm shift from a *subject-based* organization of VET programmes to a design based on *developmental logic*, as had already been advocated by Herwig Blankertz (1982). Its attainment was confronted in the practice of vocational schools with a professionalism based on academic disciplines that was deeply rooted in the thought and action of the teaching staff. This turned out to be a barrier for the implementation of the concept of learning areas. A comprehensive empirical study on this topic has been published by Waldemar Bauer (cf. Bauer 2006). Even the teachers who support the concept of learning areas as a pedagogical paradigm often express the view that its implementation is difficult due to the insufficient formulation of practical consequences and the variety of pedagogical interpretations, which are often incompatible. The interpretations of the learning area model that have been published either have the quality of blueprints which are inadequate for the complexity of this reform concept or focus on the elaboration of their scientific foundations. In the latter case, they rarely reach the level of pedagogical practice. Therefore, the COMET competence model also serves as a support for the implementation of the concept of learning areas. The competence (development) model needs to be operationalized in such a way that it can be used as a basis for the quantitative assessment of professional competences and competence development.

The measurement of vocational competences includes the outcomes and effects of vocational education that extend beyond technical or subject-specific skills. These transdisciplinary competences are regarded as a key dimension of vocational competence diagnostics since Urs Grob and Katharina Maag Merki published their study on this topic (cf. Grob and Maag Merki 2001). Setting out from the objectives of vocational education in Switzerland, this project not only achieved a systematization of the categories of transdisciplinary competences, but also an alignment with psychological models of professional identity and motivation. To some extent this concept overlaps with the COMET approach for the study of professional identity and occupational commitment. It was for the reason of a more economical research design that the COMET project chose not to analyse the transdisciplinary competences according to the indicator model by Grob and Maag Merki. This indicator model can be adopted in the context of an extended project design for the assessment of vocational competences and competence development. It would then be necessary to differentiate more precisely between competence and identity development as well as between the different dimensions of occupational commitment.

The separate assessment of vocational competence, on the one hand, and professional identity and occupational commitment, on the other hand, as envisaged by the COMET project is due to pragmatic reasons. The research design guarantees that these two aspects of personal development can be measured individually and related to each other.

Whenever the COMET project is discussed outside the consortium – e.g. at relevant scientific conferences – what suggests itself easily is a comparison to the PISA project and a reflection on the possibility to carry out international comparative studies in the field of vocational education and training on the basis of the COMET approach. Notwithstanding the difficulty to compare highly divergent national VET systems, the COMET concept offers considerable room for the coverage of countries and regions with different VET systems. This is achieved above all by the concept of *professional validity*. This means that the validity of test results has to be demonstrated with reference to the professional work and the competences embodied therein.

In the following chapters we outline and justify the principles of the COMET project and present some of the preliminary phase's results. Some of the items require a somewhat elaborate description that probably not all readers will appreciate. However, as competence diagnostics in vocational education and training is still at a pioneering stage a transparent explanation of the COMET concept is also expected to contribute to the relevant academic debate.

References

Bauer, W. (2006). *Einstellungsmuster und Handlungsprinzipien von Berufsschullehrern. Eine empirische Studie zur Lehrarbeit im Berufsfeld Elektrotechnik*. Bielefeld: W. Bertelsmann.

Blankertz, H. (1982). *Die Geschichte der Pädagogik. Von der Aufklärung bis zur Gegenwart*. Wetzlar: Büchse der Pandora.

Deutsches PISA-Konsortium (Hg.). Rost, J., Prenzel, M., Carstensen, C. H., Senkbeil, M., & Groß, K. (2004). *Naturwissenschaftliche Bildung in Deutschland. Methoden und Ergebnisse von PISA 2000*. Wiesbaden: Verlag für Sozialwissenschaften.

Gardner, H. (1991). *Abschied vom IQ: die Rahmentheorie der vielfachen Intelligenzen*. Stuttgart: Klett-Cotta. (Originalausgabe (1985). *Frames of mind. The theory of multiple intelligences*. New York: Basic Books.)

Grob, U., & Maag Merki, K. (2001). *Überfachliche Kompetenzen: Theoretische Grundlegung und empirische Erprobung eines Indikatorensystems*. Bern: Lang.

Klieme, E., & Leutner, D. (2006). Kompetenzmodelle zur Erfassung individueller Kernergebnisse und zur Bilanzierung von Bildungsprozessen. Beschreibung eines neu eingerichteten Schwerpunktprogramms der DFG. *Zeitschrift für Pädagogik*, *52*(6). 876–903.

KMK – Kultusministerkonferenz (Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland). (Hg.). (1996a). *Handreichungen für die Erarbeitung von Rahmenlehrplänen der Kultusministerkonferenz für den berufsbezogenen Unterricht in der Berufsschule und ihre Abstimmung mit Ausbildungsordnungen des Bundes für anerkannte Ausbildungsberufe*, Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland, Bonn.

KMK – Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland. (Hg.). (1996b). *Überlegungen der KMK zur Weiterentwicklung der Berufsausbildung*. Bonn.

Prenzel, M., Gogolin, I., & Krüger, H.-H. (Hrsg.). (2007). *Kompetenzdiagnostik. Zeitschrift für Erziehungswissenschaft Sonderheft 8/2007*. Wiesbaden: VS Verlag für Sozialwiss.

Rauner, F. (1988). Die Befähigung zur (Mit)Gestaltung von Arbeit und Technik als Leitidee beruflicher Bildung. In G. Heidegger, P. Gerds, & K. Weisenbach (Hg.). *Gestaltung von Arbeit und Technik – ein Ziel beruflicher Bildung* (pp. 32–50). Frankfurt am Main/New York: Campus.

Chapter 1
Measuring Professional Competence

1.1 Vocational Education and Training: A Challenge for Competence Diagnostics

The PISA consortium with its research design and methodology has set new standards for educational research and fundamentally changed the cooperation between VET research and VET policy. This is mainly due to the fact that policy makers and the scientific community alike accepted the PISA methodology almost without any reservation. This is a new situation, which since then poses a challenge for VET researchers to extend competence diagnostics to ever wider fields of application. It was thus no surprise when already in 2003 the idea of a VET PISA was proposed for the first time, to be followed in Germany shortly afterwards by a feasibility study commissioned by the Federal Ministry of Economics on an international VET PISA (cf. Baethge et al. 2006).

In the preparatory phase of the German DFG priority programme 1293 "Competence Models for the Assessment of Individual Learning Outcomes and the Evaluation of Educational Processes" (Klieme and Leutner 2006), several workshops were carried out with the support of the Federal Ministry of Education and Research. The workshop on the state of the art of competence research in vocational education and training (11–12 July 2006) was carried out by the Institute Technology and Education, University of Bremen (ITB), in cooperation with the German Institute for International Educational Research (DIPF) in Bremen (cf. Grollmann and Jude 2008).

The evaluation of the relevant activities in VET research made clear that vocational education is characterized by a variety of particulars that render the implementation of an international comparative large-scale competence assessment quite difficult. Above all three reasons can be emphasized:

1. The multitude of occupations with their highly diverse qualification and competence profiles does not allow to group them in comprehensive competence fields across occupational domains. The efforts to transcend the variety of

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professional tasks through the concepts of general technological literacy for the occupations in engineering and technology, and economic literacy for occupations in business and administration were not successful. The concepts of technological and economic literacy must be attributed to general rather than vocational education as they do not reach the level of *professional* knowledge and skills.
2. The qualification requirements in a large number of occupations are subject to a permanent and accelerating change due to technological innovations. Accordingly the development of occupational profiles and training programmes remains a permanent challenge. This is an obstacle to the use of training curricula's contents for the assessment of professional competences.
3. International comparative studies and tests are rendered difficult by the fact that professional competences are imparted in quite different ways. Skills that are acquired by the trainees in country X in the course of a dual training programme are taught in country Y by means of a school-based training programme or even through higher education and subsequent training on the job. The competences acquired in these learning pathways are difficult to compare since in the first case they are based on reflected work experience and in the second case on theoretical knowledge and skills that were acquired in a school setting. Both are at best conceptually related to each other.

On the other hand, the practice of vocational education and training is equipped with highly developed tools for testing the professional competence *to act*. The reasons are plain to see. For instance, the examination of a future aircraft pilot must ascertain without doubt that he is capable of steering an aircraft. This example represents the domain of practical tests that are indispensable for the assessment of the professional aptitude. When it comes to the assessment of skills that are crucial awarding a licence to carry out an occupation, high demands are put on the examination methods.[1]

The discussion about competence diagnostics in vocational education becomes even more difficult due to the fact that the requirements for the assessment of professional competence vary between the different occupations. For a goldsmith, for instance, artistic creativity and manual skill have high importance, whereas for a logistics specialist the explicit technical knowledge has priority. However, when Harold Garfinkel developed his "Studies of Work" research approach he came to realize that any occupation ultimately has to be learned in practice, regardless of whether it is a mathematician's or a truck driver's occupation (cf. Garfinkel 1986). Since then theory and research in vocational education can ignore this insight only at the price of not being taken seriously. The necessary consequence is that professional competence must in principle always be tested *practically* in the context of real

[1] "Integrated assessments" as well as assessment by work assignments or, more generally, practice-oriented assessment refer to modern examination types that aim to evaluate the attainment of professional aptitude in a way that is closely connected to practice (cf., inter alia, Ebbinghaus 2005; Nöh 2006; Kloft et al. 1997; Grünewald and Schmidt 2000). This has to be distinguished from the analysis of professional *competence*.

work processes, too. A large-scale competence assessment that aimed at evaluating the professional competence *to act* would therefore face an obstacle which is almost impossible to overcome. Whenever a significant number of occupations or just of participants were included in such a study, the expenditure would be so great that this test approach is not seriously under consideration. One interesting exception has to be mentioned here, namely the World Skills, which look back on a tradition of 40 years and where the champions among the 40–50 occupations that participate in this contest are decided on the basis of a practical assessment (Van Goor 2007). As in the case of the Olympic Games, the medals table of the World Skills also gives a clue what priority is given to vocational education in the participating countries.

When assessment procedures for the measurement of vocational competence (development) are theoretically established and developed, the standard approach is to look for ways of defining vocational competence in such a way as to render *practical tasks* unnecessary for their assessment. In the 1970s, a new evaluation concept referring to the development theory of Havighurst (1972) was developed, which is based on the concept of *developmental tasks*. The idea that underpins this evaluation approach can be summarized as follows: If it can be managed to describe an occupation by its characteristic tasks and to structure them according to developmental logic, then it takes only a small step to derive evaluation tasks from these professional tasks (cf. Bremer and Haasler 2004). This evaluation instrument is a procedure which requires a *hermeneutical* interpretation of the test results. Practical *test* assignments were not foreseen. What was evaluated was the *conceptual* competences in the sense of domain-specific cognitive performance dispositions. The extensive stock of empirical results and documents from this evaluation project provides the opportunity to develop this evaluation method to a large-scale diagnostics instrument (Rauner et al. 2007, 19 ff.). In order to establish this approach in further detail, it is necessary first to specify the concept of professional competence. This leads to the question what the forms of examination, competence diagnostics, and performance assessment have in common and above all what distinguishes them.

1.2 Examination and Competence Assessment: Two Distinct and Complementing Types of Evaluating Professional Competence Development

In Germany, the traditional occupations have their own and often centuries-old ways of recruiting their new members. “It is always the same kind of people starting training as a goldsmith, insurance clerk, heating engineer or toolmaker”, a career advisor says, expressing a widespread opinion. Especially in the crafts sector with its relatively stable occupations professional communities of practice have emerged, which have their own assessment procedures and evaluation standards. Apprentices and masters (examiners) view themselves as members of the same community of practice. In some sense the examiners also rate themselves in the journeyman’s examinations of their trainees. The skills of the future craftsman cannot differ very

much from the skills that characterize the professional community of practice as a whole. “Once you are ‘in’ as an apprentice, hell would have to freeze over before you don’t pass the journeyman’s examination.” If too many candidates fail in the examinations, then this is also perceived as a blemish for the guild. Therefore, only those candidates do not succeed on whom the masters agree that they are unworthy of belonging to the community. Needless to say this judgment includes the professional skills and competence as understood by the masters. So all occupations have their *specific examination standards,* which are always a reflection of the competences and expertise represented by the members of the professional community of practice. They vary strongly between the different occupations – not only in terms of content. This can be regarded as a strong point of the dual VET system with its extraordinary heterogeneity concerning the inclinations, interests, competence profiles, and school background of the trainees. Professional competence diagnostics would not fully exploit its specific potential for the measurement of professional competences if it followed these assessment practices and traditions too closely. Assessment here means in the first place the assessment of professional skills and of the corresponding work process knowledge. The focus is on the professional competence to *act*, which can be identified only in the reality of professional work by members of the relevant professional community of practice, who are acquainted with the context that is *professionally and socially situated*.

Examination, competence assessment, and performance assessment are three different things. Each of the concepts for the measurement of professional skills has specific functions. Besides testing, whose functions were discussed above, the performance assessment gives the teachers the opportunity to check the “success” of their teaching. Here the *curricular validity* of the testing methods and the content of the tests is most important.

Professional competence diagnostics has its strong point in the measurement of *cognitive* (domain-specific) *performance dispositions*. The focus is on the measurement of *professional competences* and not on the evaluation of professional aptitude in the sense of professional *action* competences. Determining the range of assessment (examinations), on the one hand, and competence diagnostics, on the other hand, in each professional domain is a challenge for VET research. Of course the skills of a goldsmith can be rated only by a master in the field. This requires neither a competence model nor psychometrically tested indicators. Whether or not a trained goldsmith has reached the level of craftsmanship is recognized by the masters primarily on the basis of the candidate’s ability to design and craft his pieces in a creative and skilful manner so as to stimulate the emotional responses on the part of the customers that motivate the latter to buy his products. Needless to say a goldsmith can successfully exercise his trade only when he also uses his raw material economically, applies efficient methods of producing his goods, is able to weigh costs and revenue, presents his works adequately, and finds customers to buy his products. For an industrial clerk, a ship mechanic, or a car mechatronic, the questions related to the assessment of their professional aptitude are different. The variety of occupations is too big to establish uniform assessment procedures. This is shown by the practice of occupational curriculum development.

The specific relevance of competence diagnostics is rooted in the fact that it offers the opportunity to integrate, on the basis of theoretically and normatively justified competence models, the guiding principles of vocational education and training and the assessment tasks by means of which the attainment of these principles in the sense of cognitive domain-specific performance dispositions can be evaluated. What is particular about this method is the opportunity to compare individuals, training institutions, and different models of the organization of vocational education, embedded into different educational traditions and systems. The collection of contextual data and the measurement of the development of professional identity and commitment allow insights into vocational learning of an unprecedented depth. The international PISA project has demonstrated in the most convincing manner that the foundations for education policy and educational planning can be considerably broadened and deepened this way. This is particularly relevant for the organization of the transition from vocational to higher education. It is obvious that in this context information about the cognitive performance dispositions of those who underwent vocational education is of paramount interest. If the concept of professional competence as cognitive dispositions is developed with reference to the particulars of professional work and vocational education, then it becomes clear that the methods of competence diagnostics allow an assessment that extends beyond the so-called technical or professional knowledge. Therefore, a close approximation of competence diagnostics to the tradition of examinations would fail to exploit the potential of competence diagnostics.

1.3 Professional Competence: A Conceptual Clarification

If the assessment of practical skills is excluded from competence diagnostics, the question arises what is meant by professional competence and what is the use of a methodology that is confined to the measurement of context-specific cognitive performance dispositions (cf. Hartig and Klieme 2006, 128 f.). Competence has to be distinguished from *intelligence*, on the one hand, and *qualification*, on the other hand.

Not only in Germany, the term "competence", interpreted as "professional competence to act", plays a major part in the debates in vocational pedagogy and especially in the system of examinations. The professional *action competence* – the competence to act professionally in one's occupation – is regarded as an indicator of the level of professional aptitude. This expresses the expectation that after passing the final examination the trainee is equipped with the knowledge, abilities, and skills (qualifications) defined in the vocational curriculum. Qualifications are defined on the basis of the requirements for the fulfillment of professional tasks. This means that in the description of qualifications the performance, that is, the observable application of professional skills, is in the center. For instance, in the production of a specific lathe component, the quality of the product is precisely defined by the specification of tolerance limits, surface quality, etc. The description of the technical quality of the product defines the relevant qualification for the occupation

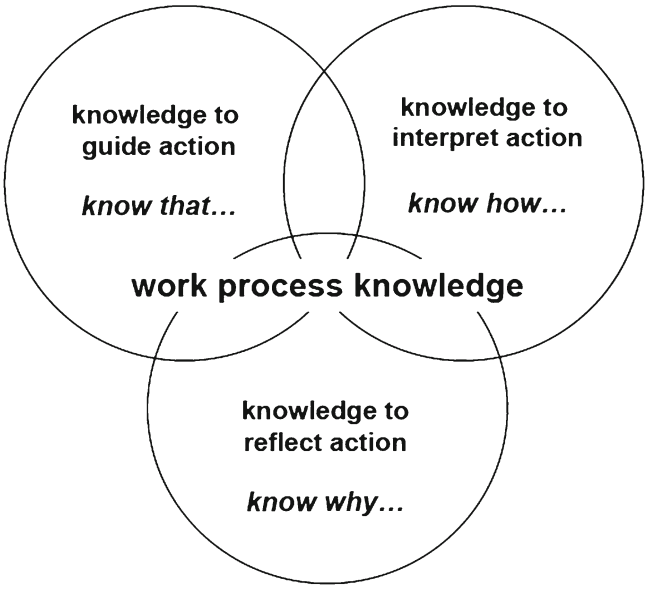

Fig. 1.1 Professional work process knowledge

of lathe operator. When the qualification is assessed in the final examination, the items evaluated apart from the professional skills are the knowledge to guide actions (know that), the knowledge to interpret actions (know how), and the knowledge to reflect actions (know why) (see Fig. 1.1).

When specific qualification requirements are indispensable for the exercise of the profession in question, the technological efforts put on the assessment methods are particularly high. An example is welding, where the quality of a weld seam has to be evaluated according to physical and technological criteria. The assessment of safety-relevant knowledge and skills is typically carried out by institutions that are especially accreditated for this purpose. Unlike the concept of qualification, the criterion of professional competence refers to the domain-specific cognitive dispositions for performance.

For Erpenbeck and von Rosenstiel (2003), the crucial difference between qualification and competence is that qualifications become manifest not only in self-organized action, but in standardized test situations that can be worked on step by step. Vocational qualifications are constituted by objective features of work assignments and business processes in the companies.

A more precise conceptual distinction of qualification and competence can be achieved with the help of the criteria proposed by Hartig and Klieme, namely (1) object and subject relatedness, (2) learning, and (3) objectivization.

The distinction between object and subject relatedness in professional skills allows to determine precisely whether a particular skill is constituted by the objective circumstances of a work task (cf. Table 1.1).

Table 1.1 Comparison of conceptual features of "qualification" and "competence"

	Qualifications	Competences
Object-subject relation	Qualifications are objectively defined by the work tasks and processes and the related demands.	Competences are domain-specific abilities and strategies in the sense of mental performance dispositions; their applicability is open.
Learning	In the process of acquiring qualifications the human being is a holder of qualifications, a (human) resource that is prepared by training for the performance of specific activities.	The acquisition of competences is a part of personality development and includes the skills defined by the educational objectives.
Objectivization	Qualifications describe the skills and abilities that have not yet been objectivized or mechanized, and define the human being as a holder of qualifications that are derived from work processes.	Professional competences focus above all on skills that are difficult or impossible to objectivize and which extend beyond current professional tasks to the mastering of future tasks.

Two kinds of qualifications can be distinguished, namely those for which the "knowledge to guide action" on which they are based can be precisely defined, and those which can be described in terms of results, but which are based on implicit knowledge that is incapable of any explicit description. These skills are beyond the reach of competence diagnostics, but not beyond the limits of qualification research and assessment practice since the latter are equipped with methods that make it possible to decode, describe, and test the qualification requirements. The more comprehensive the implicit skills that enable a person to exercise specific tasks, the narrower are the limits for the objectivation of these qualifications.

Under the aspect of the possible objectification of professional skills, the learner is seen as a *holder of qualifications* who can be replaced by a technical system when the tasks in question can be objectified. *Humans and machines, under the aspect of qualification, are interchangeable holders of qualifications* (Huisken 1975, 130 ff.). From this point of view, human qualifications are always a residual quantity in the process of progressive objectification of abilities and skills. Professional competences, on the other hand, refer to skills that are based on the specific human and personal intelligence and which remain oriented towards the emancipation of skilled workers in the interaction of humans and machines.

Professional competences, on the other hand, denote skills in the sense of subjective potentials that refer to the solution of a class of tasks whose context is defined only by an occupation or a unit within a vocational curriculum, but not by concrete work tasks. The professional tasks are defined only in terms of their general characteristics, but not in terms of their specificity. Therefore, competences are open for different contexts of application.

Learning in the process of professional qualification means the acquirement of competences. Learning in the sense of acquisition of qualifications is not understood as a dimension of personality development, but as a necessary requirement for the appropriate exercise of an activity. Competence and competence development, on the other hand, refer to the development of the personality. Vocational proficiency includes the dimensions of understanding, reflection, and evaluation of the professional tasks and their solution as well as the ability to contribute to the shaping of work processes instead of merely implementing them on the basis of detailed directives (Rauner 1988; Heidegger et al. 1991; KMK 1991).

Hartig and Klieme, referring especially to Weinert (2001), propose to view competences as context-specific cognitive dispositions as they would be to some extent generalizable for similar situations. This definition, which expresses a majority view in competence diagnostics, is characterized by two limitations:

– Competences are defined by functions. They refer to domains. In vocational education and training these domains are occupations or occupational groups.
– General intellectual faculties are not covered by this definition of competence.

In order to justify his position Weinert refers to two points.

1. Universal basic cognitive functions have to be viewed as part of a basic equipment common to all humans, which need not be acquired to cope with specific requirements. The current state of research suggests that these basic functions can be influenced by training or other external interventions only to a limited extent (cf. Hartig and Klieme 2006, 129).
2. The second limitation consists in the exclusion of motivational and affective prerequisites for successful learning.

The second restriction cannot be applied to vocational education as the development of professional competence is linked to the development of professional identity and commitment. Without this linkage, competence development cannot be explained (Blankertz 1983). Apart from professional competence, professional identity as well as the sense of responsibility, quality awareness and performance orientation based on this identity are equally important objectives of vocational education.

Hartig and Klieme's distinction between the concepts of competence and intelligence uses the criteria of contextualization, learnability, and internal structure (cf. Table 1.2).

With regard to the design of test assignments in vocational education this means that the tasks have to be close to reality and with reference to the professional work tasks that are defined by the description of occupational profiles.

To relate intelligence and competence is difficult when the traditional definition of intelligence is adopted, according to which intelligence is the general capacity to solve problems. If Howard Gardner's concept of multiple intelligence (Gardner 2002) is adopted instead, then it is possible to describe professional competence development as the realization of abilities whose development is structured by

Table 1.2 Comparison of conceptual features of "competence" and "intelligence"

Competence	Intelligence
Contextualized ability to respond adequately to specific situations and demands.	General ability to solve new problems
Can be learned and is acquired through experience with specific situations and demands.	Stable over time and determined by biological factors to a significant extent.
Internal structure is determined situations and demands.	Internal structure is determined by fundamental cognitive processes.

Source: Hartig and Klieme (2006, 131)

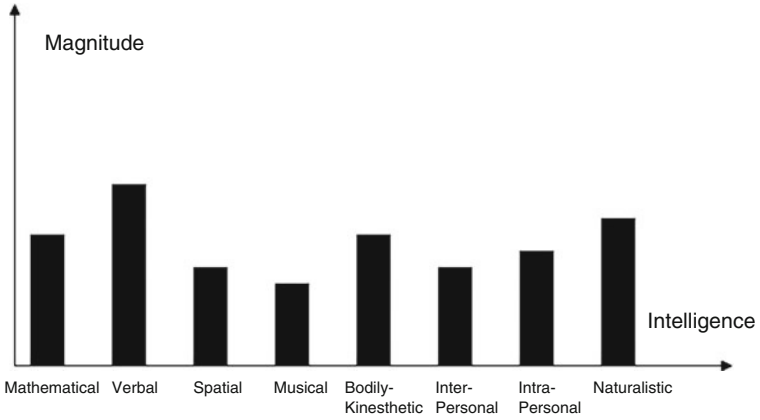

Fig. 1.2 Example of an individual intelligence profile (Source: Connell et al. 2003, 138)

specific intelligence profiles. Gardner distinguishes eight types of intelligence, which are realized in individuals to very different extents (see Fig. 1.2).

The concept of multiple intelligence also allows to distinguish occupations or professions according to their characteristic intelligence profiles (Connell et al. 2003). Abilities can be conceptualized as functionally integrated intelligence profiles. The realization of specific types of intelligence constitutes a sphere for competence development or potential abilities (see Fig. 1.3).

The concept of multiple intelligence offers the opportunity to map the domain-specific abilities much more precisely than the usual differentiation of competence dimensions into technical, social, and personal competence does. This competence model, which is widely spread in the vocational pedagogical discussion, implicitly suggests a VET practice in which all competence dimensions have to be developed evenly. The concept of multiple intelligence and the corresponding model of multiple competence, on the other hand, emphasize the *potentials for competence development* that are given by the context of professional work and the intelligence profile of the individual. These potentials vary considerably not only between individuals, but also between occupations (cf. Rauner and Grollmann 2006, 122 ff.).

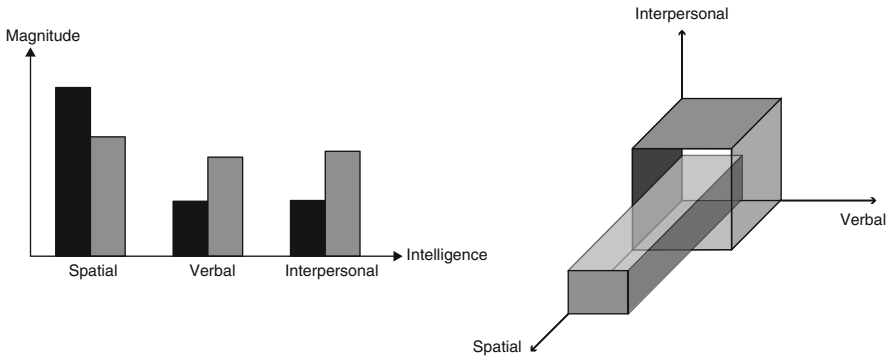

Fig. 1.3 Two different intelligence profile and the spheres for competence development they constitute (Source: Connell et al. 2003, 140 f)

The COMET competence model meets the requirements for a differentiated concept of multiple competence in a threefold way.

1. The test assignments are derived from characteristic professional work tasks. They have the quality of professional developmental tasks and thus represent the characteristics of the profession in question. The problematic notion of "technical competence" is hereby avoided. The variety of competence profiles expressed in the various occupations is retained and not evened out by a concept of professionalism that is based on vocational disciplines.
2. Structuring the professional work tasks in vocational curricula (and processes of professional competence development in general) according to developmental logic makes it possible to describe professional competence development in its qualitative characteristics and not just as a process of quantitative increase of technical competence. Beginners (novices) not only know and can do less than professional experts, but the subjects of their knowledge and learning are fundamentally different. This aspect of multiple competence is increasingly taken into consideration when vocational learning processes are structured according to developmental logic.
3. Finally, the competence model is multiple also in the sense that three qualitatively defined competence levels are identified, which can be described by means of eight competence dimensions (see Chap. 3).

This definition of competence provides the basis for a competence diagnostics that neither replaces competence with generic concepts of intelligence and literacy nor reduces it to qualifications related to single work tasks. This competence diagnostics is appropriate for identifying the contribution of the vocational school to the trainees' competence development as well as for examining the cognitive performance dispositions that form the basis of professional activity in the world of work. This includes those competences that are acquired in the context of in-company training. The quantitative and qualitative relevance of the two learning venues for the development of professional competence cannot be determined exactly on the basis

of the competence model presented here. However, the testing concept makes it possible to measure "professional" and not just "technical" competences.

This is achieved thanks to the fact that the development of test assignments takes place not on the basis of *curricular*, but *professional validity*. The *curricular* validity of test assignments would limit their functionality with regard to the evaluation of different types of vocational education and training, including the quality of vocational curricula. Action-oriented school-based forms of learning, learning in the work process, learning in an experimental laboratory setting, etc., require test assignments that take the "paradigmatic work situations" of skilled work (Benner 1995) into account. The assignments have *professional validity* when they are derived from the work situations that characterize an occupational profile. Their identification first of all requires an analysis of the objective elements that constitute a defined occupation:

- The topics of skilled work
- The tools, methods, and work organization
- The (competing) requirements of professional work

The most promising way to formulate and organize the relevant work tasks is the instrument of "expert workers workshops" (see Bremer et al. 2001). On the basis of a large number of workshops, it was possible to work out a training concept with a sound basis in developmental theory. The expert workers describe their own professional development, which leads to the integration into a professional community of practice. They do so with the help of professional work tasks and with a view to three dimensions:

- The mastery of technology, tools, and methodology of their work
- The mastery of skilled work in terms of the (diverging) requirements of the work tasks and the tools and methods to be employed
- The mastery of the rules of social organization in the interaction with colleagues, superiors, and customers

The consequences for a work-based didactical approach and a corresponding curriculum for vocational education and training are clear. For a trainee the new tasks and situations at the start of their training programme are the beginning of the development of professional identity and competence.

Test assignments that are professionally valid in this sense make it possible to identify strengths and weaknesses of different VET systems and arrangements. In particular, they provide the opportunity to examine whether trainees have a *concept of professional work* and not just technical and functional knowledge, the latter being typical for school-based types of vocational education (Bauer 2006). Accordingly this test concept is also applicable in international comparative studies, for which it can safely be assumed that vocational education in different countries is not always organized according to the principle of dual vocational education and training. However, for an international comparative competence diagnostics it needs to be clarified whether the contents and the organization of *professional work*, which form the basis of the training programmes, are comparable.

1.4 Professional Creativity as a Topic of Competence Diagnostics

Creativity plays an important part for professional competence since professional tasks are usually not associated with *algorithmic solutions and problem solving processes*, but allow for solutions whose variety constitutes a more or less extensive solution space. In the arts and crafts, for instance, the room for maneuver for possible solutions is much bigger than in the manufacturing trades.

Unlike the case of education in the natural sciences, where the focus is on the *correct* understanding and application of the laws of nature, solutions for professional tasks are evaluated according to weather and to what extent they meet the criteria of *suitability*, whether the means employed for the attainment of the end were selected according to the principle of proportionality, etc. What is at stake is the consideration and weighting of a number of criteria whose sum results in an optimal (not just a correct!) solution. Moreover, a solution is optimal only for a specific situation. The optimum may shift already for another user with different habits and interests.

A solution is creative if in the case of open – non-deterministic – assignments conflicting requirements are reconciled in a convincing way. This presupposes an extensive understanding of a whole problem area as well as a user-oriented interpretation of the task context in terms of subject-matter and social situatedness.

This leads us to the problem of the *occupation-specific distinction of creativity*. From the points of view of a goldsmith, an insurance clerk or a nurse the creative exercise of their professional tasks means fundamentally different things.[2]

In the COMET approach a different strategy is followed. Creativity is established as one of three indicators for the definition of *shaping competence*. In this context creativity or creative solutions are operationalized by means of five items (see Table 1.3). These items are not arranged in a hierarchical order and they all have the same weight. The operationalization is shown in Table 1.3.

Table 1.3 Operationalization of 'professional creativity'

1. How original is the solution? Does it differ from the usual patterns?
2. Is an unusual solution developed that also makes sense?
3. Does the solution have an aesthetic value?
4. Does the solution show problem sensitivity?
5. Is the room for maneuver associated with the task fully exploited?

[2] It is not our aim here to investigate whether there is, besides the professional distinction of creativity, a fundamental potential of creativity in the sense of a general personality trait, and if so, in what way personalities with higher or lower levels of creativity might differ.

1.5 Potentials and Limits of Competence Measurement

The measurement of professional competence means in the first place that the measurement tools are based on standardised measurement methods and target forms of professional knowledge and skills that can be *measured*. Many aspects of professional skills, including important ones, escape the methods of quantitative measurement, though. Quite often the "tacit knowledge" (Polanyi 1966; Neuweg 2000; Fischer 2000) is the basis of important professional skills that can be demonstrated in an examination but not described in the form of explicit knowledge. When a toolmaker is asked how he manages to carve a steel surface more exactly than a machine would do, the sybillinic reply is often: "That's experience" (Fischer et al. 1995).

At this point large-scale competence diagnostics reaches its limits for two reasons:

- Large-scale competence diagnostics depends on standardized test procedures. The latter are incompatible with the idea of assessing practical skills in real work situations.[3]
- The realization of a standardized observation procedure for the assessment of professional competence by proven experts would require an amount of human and temporal resources that rules out the feasibility of such a project from the outset.
- To determine the limits of competence diagnostics it is necessary to examine in some detail those competences that cannot or can only be measured with greater efforts or further methodology. These are the following aspects of learning and skills.

1.5.1 Implicit (Tacit) Professional Knowledge

In competence research, measuring means to formulate test assignments that allow test persons to explicitly demonstrate their abilities (in the sense of cognitive performance dispositions). Accordingly the knowledge to explain actions (know how) is an important aspect of professional competence. Implicit knowledge and skills can be observed and evaluated during the exercise of professional activities and especially on the basis of the work results. On the other hand, they cannot be described and explained in explicit technical terms. Skills that cannot be explicated in this way are often fundamental for professional competence and therefore covered by examinations, but they are inaccessible for the established methods of competence diagnostics.

[3] The question as to whether it is possible to assess professional skills with the help of standardised 'work samples' and under the conditions of a standardised simulation of work practice cannot be expanded here. It can be assumed that the use of simulation techniques, e.g. in the training of pilots by means of flight simulators or in the evaluation of skills in geriatric care by the 'Objective Structured Clinical Evaluation' (OSCE), allows for the assessment of significant parts of professional skills. However, these techniques are not a complete substitute for the evaluation of qualifications in the context of real work processes.

1.5.2 Professional Action Competence (Professional Aptitude)

Professional aptitude is usually established by more or less traditional forms of assessment. Apart from the assessment of professional knowledge, the aim of examinations is particularly to evaluate the practical skills in real work situations against the benchmark of the qualification requirements defined in the occupational profiles. Therefore, assessment includes the proof of sufficient practical experience during the training period. If possible, all qualifications that are relevant for the professional aptitude are assessed. This is necessary for a professional assessment practice to allow for the certification of professional aptitude, which is often associated with the awarding of a licence.

Competence diagnostics, on the other hand, does not cover all professional requirements. This would bring about grave difficulties at the level of practical implementation. Instead, typical professional contents and requirements are selected in such a way as to allow for the measurement of cognitive dispositions that are used also for the fulfillment of other professional tasks.

1.5.3 The "Increment of Learning"

The increment of learning is an essential part of any practice of teaching and training. Teachers and trainers monitor regularly whether and to what extent the learning objectives are fulfilled and how they succeed in supporting the trainees in their individual professional and personal development. To this end they can use a broad range of informal tests and various evaluation methods. This way they gain information about the trainees/students, on the one hand, and their own pedagogical activities and the quality of learning arrangements, on the other hand. Teaching curricula and training regulations constitute the point of reference for this type of performance assessment. Evaluation and assessment along the training process, like situated learning, escapes any form of standardization.

The educational standards formulated for specific subjects by the authorities responsible for education suggest the introduction of standardized test procedures like those used for competence diagnostics. Whether or not the increasing outcome orientation in the management of the education system will have an impact on the methods of performance assessment is an open question. The risk entailed by the introduction of testable educational standards is that learning objectives that cannot be operationalized by standardized tests – and these objectives are likely to be more essential than those that accessible for standardized procedures – might lose importance.

One particular of vocational education and training has to be mentioned here. Learning in the work process has the consequence that the criteria for successful learning are derived directly from the quality standards entailed by the business and

work processes that are embedded in the organizational structures of the enterprise. Accordingly the validity of performance assessment is also based on the criteria of corporate quality management.

1.5.4 Manual Skill

Manual skill is an important indicator of professional competence in many occupations – not only in the arts and crafts (Sennett 2008). Manual skill also escapes the reach of large-scale competence diagnostics. Skillfulness requires a good deal of experience and also a minimum of kinesthetic intelligence (cf. Gardner 2002). Dental technicians, goldsmiths, but also toolmakers and other industrial and technical trades belong to a group of occupations where manual skill is a core element of professional aptitude. By contrast, when the associated category of talent is applied to personal services, this is rather due to the prejudice that, e.g., the professional performance as a teacher is something that cannot simply be learned.

1.5.5 Social Competences

Social competences are of crucial importance in professional work and therefore as well in vocational education. It is disputed whether social competence can be assessed as transoccupational "key competences". According to Gerstenmaier, the results of learning and expertise research refute the hypothesis of a devaluation of technical knowledge in favor of generic skills like "problem solving". Instead it can be demonstrated that the competence to solve problems is based on domain-specific knowledge (Gerstenmaier 1999, 66; Gerstenmaier 2004, 154 ff.).

There is a consensus that professional work necessarily involves cooperation with skilled workers from the same community of practice as well as experts from adjacent fields, which represents a core dimension of professional competence. This is an area that is only partly accessible for a competence diagnostics with a focus on individuals. In the COMET project the context survey (see Chap. 4) delivers some information about the respondents' concepts of professional collaboration.

1.5.6 Skills That Are Expressed in the Interactive Course of Work

These skills are based on the design-oriented type of activity as opposed to the instrumental-rational type (cf. Brater 1984). According to Brater artistic work is the prototype of this type of activity. Here the ultimate result of the work can be

anticipated by planning only to a limited extent. Unlike the designer, who determines the final shape of the product by drawing a blueprint, the work of an artist gradually takes shape out of an idea. The reality of the enterprise, contrary to the idea suggested by the methods and results of work process analysis, is also largely characterized by informal structures and thus escapes a standardization or formalization to some extent. Especially in the field of secondary skilled work (maintenance, error diagnosis and the like) it is necessary "to look for opportunities, develop ideas and find solutions out of the situation. What is required here is not adherence to schedules, but originality" (Brater 1984, 67). Whenever the type of design-oriented, creative and situative activity is in place, the assessment of professional competences reaches its limits. To some extent open test assignments allow for the investigation of aspects of shaping competence that are linked to the open course of work processes. The comparison of alternative approaches, tools and materials and the weighting of criteria that are relevant for problem solving are therefore also an expression of shaping competence, as is the competence criterion of creativity.

References

Baethge, M., Achtenhagen, F., Babic, E., Baethge-Kinsky, V., & Weber, S. (2006). *Berufsbildungs-PISA. Machbarkeitsstudie*. München: Franz Steiner Verlag.

Bauer, W. (2006). *Einstellungsmuster und Handlungsprinzipien von Berufsschullehrern. Eine empirische Studie zur Lehrarbeit im Berufsfeld Elektrotechnik*. Bielefeld: W. Bertelsmann.

Benner, P. (1995). *Stufen zur Pflegekompetenz. From Novice to Expert*. Bern: Hans HuberVerlag.

Blankertz, H. (1983). Sekundarstufen II – Didaktik und Identitätsbildung im Jugendalter. In D. Benner, H. Heid, & H. Thiersch (Hrsg.), *Beiträge zum 8. Kongress der Deutschen Gesellschaft für Erziehungswissenschaft* (ZfPäd, Beiheft 18, pp. 139–142). Weinheim: Beltz.

Brater, M. (1984). Künstlerische Übungen in der Berufsausbildung. In Projektgruppe Handlungslernen (Hrsg.), *Handlungslernen in der beruflichen Bildung* (pp. 62–86). Wetzlar: W.-von Siemens-Schule, Projekt Druck.

Bremer, R., & Haasler, B. (2004). Analyse der Entwicklung fachlicher Kompetenz und beruflicher Identität in der beruflichen Erstausbildung. *Zeitschrift für Pädagogik*, *2*, 162–181. Weinheim: Beltz.

Bremer, R., Rauner, F., & Röben, P. (2001). Experten-Facharbeiter-Workshops als Instrument der berufswissenschaftlichen Qualifikationsforschung. In F. Eicker & A. W. Petersen (Hg.), *Mensch-Maschine-Interaktion'. Arbeiten und Lernen in rechnergestützten Arbeitssystemen in Industrie, Handwerk und Dienstleistung* (pp. 211–231). Baden-Baden: Nomos.

Connell, M. W., Sheridan, K., & Gardner, H. (2003). On abilities and domains. In R. J. Sternberg & E. L. Grigorenko (Eds.), *The psychology of abilities, competencies and expertise* (pp. 126–155). Cambridge: Cambridge University Press.

Ebbinghaus, M. (2005). *Stand und Perspektiven bei beruflichen Prüfungen – Ansätze zur Reform des Prüfungswesens in der dualen Ausbildung*. Bielefeld: Bertelsmann.

Erpenbeck, J., & von Rosenstiel, L. (2003). *Handbuch Kompetenzmessung: Erkennen, verstehen und bewerten von Kompetenzen in der betrieblichen, pädagogischen und psychologischen Praxis*. Stuttgart: Schäffer-Poeschel Verlag.

Fischer, M. (2000). *Von der Arbeitserfahrung zum Arbeitsprozesswissen. Rechnergestützte Facharbeit im Kontext beruflichen Lernens* (Habilitationsschrift). Opladen.

Fischer, M., Jungeblut, R., & Römmermann, E. (1995). Jede Maschine hat ihre eigenen Marotten! In *Instandhaltungsfacharbeit in der rechnergestützten Produktion und Möglichkeiten technischer Unterstützung*. Bremen: Donat Verlag.

Gardner, H. (2002). *Intelligenzen. Die Vielfalt des menschlichen Geistes*. Stuttgart: Klett-Cotta.
Garfinkel, H. (1986). *Ethnomethodological studies of work*. London: Routledge/Kegan Paul.
Gerstenmaier, J. (1999). Situiertes Lernen. In C. Perleth, & A. Ziegler (Hrsg.), *Pädagogische Psychologie*. Bern: Hans Huber Verlag.
Gerstenmaier, J. (2004). Domänenspezifisches Wissen als Dimension beruflicher Entwicklung. In F. Rauner (Hg.), *Qualifikationsforschung und Curriculum* (pp. 151–163). Bielefeld: W. Bertelsmann.
Grollmann, P., & Jude, N. (2008). Kompetenz in der empirischen Bildungsforschung und in der Beruflichen Bildung – Anknüpfungspunkte für einen hoffentlich fruchtbaren Dialog. In J. Hartig, N, Jude, & E. Klieme (Hrsg.), *Kompetenzerfassung in pädagogischen Handlungsfeldern: Theorien, Konzepte und Methoden* (pp. 141–152). Bonn: Bundesministerium für Bildung und Forschung (BMBF).
Grünewald, U., & Schmidt, J. (Hrsg.). (2000). *Innovative Ansätze beim Lernen durch Arbeit und der beruflichen Prüfungen*. Bielefeld: W. Bertelsmann.
Havighurst, R. J. (1972). *Developmental tasks and education*. New York: David Mc Kay Company (Erstausgabe 1948).
Heidegger, G., Jacobs, J., Martin, W., Mizdalski, R., & Rauner, F. (1991). *Berufsbilder 2000. Soziale Gestaltung von Arbeit, Technik und Bildung*. Opladen: Westdeutscher Verlag.
Huisken, F. (1975). Zur Kritik des Ansatzes bürgerlicher Curriculumtheorie. In K. Frey (Hg.), *Curriculum Handbuch, Band I* (pp. 126–139). München/Zürich: R. Piper & Co. Verlag.
Klieme, E., & Leutner, D. (2006). Kompetenzmodelle zur Erfassung individueller Kernergebnisse und zur Bilanzierung von Bildungsprozessen. Beschreibung eines neu eingerichteten Schwerpunktprogramms der DFG. *Zeitschrift für Pädagogik, 52*(6), 876–903.
Kloft, C., Haase, K., Hensgen, A., & Klieme, E. (1997). *Projekt PROOF: Entwicklung neuer Methoden zur Erfassung beruflicher Handlungskompetenz*. Bericht über die erste Projektphase September 1994 bis September 1996. Bonn: Institut für Bildungsforschung.
KMK – Kultusministerkonferenz (Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland). (Hg.). (1991). Rahmenvereinbarung über die Berufsschule. Beschluss der Kultusministerkonferenz vom 14./15.3.1991. *Zeitschrift für Berufs- und Wirtschaftspädagogik*, *7*, 590–593. Bonn.
Neuweg, G. H. (2000). *Wissen – Können – Reflektion. Ausgewählte Verhältnisbestimmungen*. Innsbruck: Studien Verlag.
Nöh, H. (2006). *Prüferleitfaden für handlungsorientierte Prüfungen in den Ausbildungsberufen im Baugewerbe*. ZWH (Hrsg.) Düsseldorf: Zentralstelle für die Weiterbildung im Handwerk.
Polanyi, M. (1966). *The tacit dimension*. Garden City: Doubleday & Company.
Rauner, F. (1988). Die Befähigung zur (Mit)Gestaltung von Arbeit und Technik als Leitidee beruflicher Bildung. In G. Heidegger, P. Gerds, & K. Weisenbach (Hg.), *Gestaltung von Arbeit und Technik – ein Ziel beruflicher Bildung* (pp. 32–50). Frankfurt am Main/New York: Campus.
Rauner, F., & Grollmann, P. (2006). Berufliche Kompetenz als Maßgabe für einen europäischen Berufsbildungsraum – Anmerkungen zu einem europäischen Qualifikationsrahmen (EQF). *Recht der Jugend und des Bildungswesens, 3*, S. 377–S. 386.
Rauner, F., Grollmann, P., & Martens, T. (2007). *Messen beruflicher Kompetenz(entwicklung)* (ITB – Forschungsbericht, 21/2007). Institut Technik und Bildung (ITB), Bremen.
Sennett, R. (2008). *The craftsman*. New Haven: Yale University Press.
Van Goor, E. (2007). Wettbewerb EuroSkills fördert Exzellenz und Stolz auf die Berufsbildung. In *cedefop-Info, 2/2007* (pp. 1–2). Thessaloniki: CEDEFOP Europäisches Zentrum zur Förderung der Berufsbildung.
Weinert, F. E. (2001). Concept of competence: A conceptual clarification. In D. S. Rychen & L. H. Salganik (Eds.), *Defining and selecting key competencies* (pp. 45–65). Seattle/Toronto/Bern/Göttingen: Hogrefe & Huber.

Chapter 2
Foundations of a Competence Model

The impact of vocational education on competence development cannot be estimated as long as the desired outcomes of programmes and institutions of vocational education have not been spelled out. After all, vocational training processes are based on the intention to influence the process of learning action-guiding rules that are valid not by virtue of natural or technological "regularities", but by virtue of social convention. A model of *professional* competence development therefore always includes a normative component (Brandstädter 1984). Accordingly we first have to discuss some aspects of the normative and curricular foundations of vocational education. The framework of vocational education can be based on the following four components:

- The concept of professional knowledge
- The learning objective "action and shaping competence"
- The objective of professional aptitude as defined in the occupational profiles and curricula
- The theories of professional competence development (Fig. 2.1).

2.1 Professional Knowledge

The competence model of the COMET project is based on normative foundations, on the one hand, and relevant empirical research, on the other hand. Concerning the latter a particularly important contribution is the concept of scientific literacy, which was the basis of the PISA study and which has its origin in the work of Bybee (1997).

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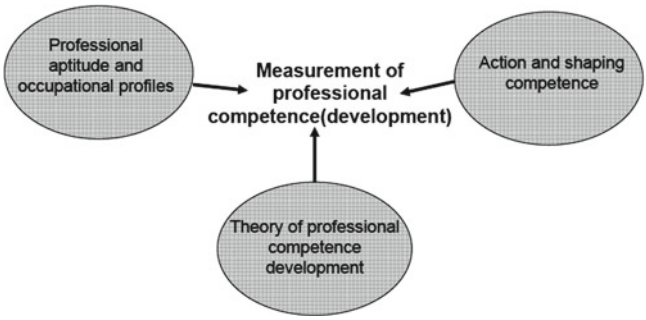


Fig. 2.1 Conceptual framework for the measurement of professional competence (development)

The development of task assignments for testing scientific competence in the course of the PISA study took four concepts into consideration:

1. Thermal conductivity
2. Rate of reaction
3. Cell
4. Continental drift

These concepts were applied to real-life scientific problems, which were taken from the "areas of application", "science in life and health", "science in earth and environment", and "science in technology" (cf. OECD 1999, 68).

This view of technology as "applied science" is debated critically in vocational and technical pedagogy. Technology is viewed above all under the aspect of the *design of technology*. It was especially the research on technology genesis as well as the international debate on technology didactics that made a significant contribution to overcoming the deterministic view of the application and effects of technology as "applied science". When a theory of technology is not confined to explaining how technology works, but also addresses the question why it is shaped this way rather than another and how the processes of genesis and design take place as part of the development of society, it needs a pedagogy of technology (ITEA 2003; Ropohl 2004) and a variety of vocational disciplines that address these questions (Bannwitz and Rauner 1993; Petersen 1996).

For competence diagnostics, this means that the characteristic work tasks of the occupational profile in question have to be used as the starting point. If professional competence is not rooted in the concept of "profession" (*Beruf*) and the related professional *competence to act*, but in the systematic structure of technical subjects, then "technical" competence is assimilated to the categories of the subjects in general education.

The contents of vocational education and training can be described in terms of the work process related dimensions of work and learning. The differentiation according to the subject, the methods, the tools, and the organization of professional

work as well as the demands put on the former is the basis for the development of professional curricula that meet the criteria of work and business process orientation.

The subject-matter of professional work

The subject-matter of work becomes a topic for the analysis and organization of work and learning from the perspective of professional work processes. It refers to work-related meanings and their representation in the professional terminology. For a machine operator, a lathe technician, or an industry electronics technician, the terminological connotations of working on a specific machine are quite diverse due to their different professional qualification profiles. The subject also includes manuals and other related documents. In business or clerical occupations, the subject-matter is usually the description of the work assignment or the problem to be solved. In science and research, the identification of the research problem is an essential work task. Once again there is the possibility that "one and the same thing" becomes a research topic under highly diverse aspects in different disciplines.

Tools, methods, and organization of skilled work

Here the perspective of occupation and work – the domain-specific and situative context – decides under what aspects the tools, methods, and organization of work become a topic for research and development in vocational pedagogy. Universal tools, like computers, need to be described as specific tools for specific professional work tasks. Novices and experts usually take different approaches to the solution of tasks: they do not only use different tools, but their work tasks are also embedded into the work organization in different ways. Information on the organization of work is crucial for the design of VET curricula and processes as well as for the quality of work and learning processes.

Requirements for skilled work

The requirements for professional work are determined by the instructions of customers and the directives of the legislature, public authorities, and the industry (ISO etc.), by the enterprise and also by the subjective interests of the employees. The variety of requirements is not only an effect of heterogeneous regulatory spheres (e.g., environment, work safety, technology), but also an expression of the manifold interests of stakeholders. Each work situation is therefore characterized by explicit and implicit compromises that have to be reached between the different and sometimes contradictory requirements. The core idea of shaping competence presupposes that this variety of requirements be documented and thus made available for the organization of work and learning processes.

Viveca Lindberg reports about a shift of perspective towards work process orientation in Scandinavia in the 1990s, and about the changing professional identity of vocational schoolteachers, which was the basis of their teaching activities (Lindberg 2003). This work drew especially on the findings of Engeström (2001), Engeström and Cole (1993), Lave and Wenger (1991) as well as Säljö (2000). Lindberg analyses the differences between vocational and subject-specific learning – learning in the work process and school-based learning.

> On a general level the main objective of activity within an apprenticeship is production. The apprenticeship is part of the production process and therefore the social practice development is based on production. For the social practice of school, the main focus of activity is learning (Carlgren 1999), but there can not be learning without content (Hirst 1974, 41).

Lindberg summarizes the results of her empirical analysis of the professional roles of VET teachers in a concept of "Content in Vocational Education". The vocational

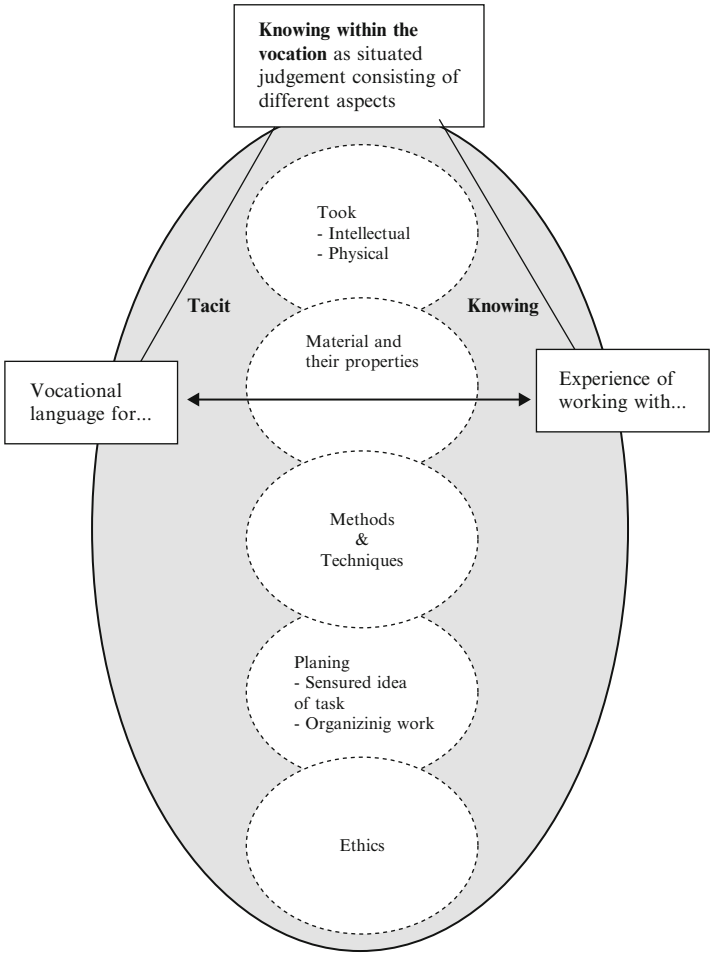


Fig. 2.2 Knowing within the vocation (Lindberg 2003, 46)

knowledge ("knowing within the vocation") is a result of reflected work experience as described by Donald Schön:

> Experience of working with different tools, methods, techniques and materials, and of planning and assessing one's work, contributes to developing a situated judgement. However more activity – doing different tasks related to a vocational area – does not result in a situated judgement – reflection on this activity is also needed (Schön 1983, 4–5).

The description of the contents of professional work and learning by Lindberg takes place according to the work-related categories shown in Fig. 2.2:

- *Tools:* "Each vocation has a set of tools that are needed in performing the work."
- *Materials and their properties:* "A vocational language needed for many categories and identifying materials and their properties."

Table 2.1 Comparison of the dimensions of professional work and learning

The dimensions of professional working and learning identified by Petersen and Rauner are	The dimensions of vocational learning (knowing within the vocation) identified by Lindberg are
Subject-matter of professional work and vocational learning	Materials and their occupation-related properties
Tools	Tools
Methods	Methods and techniques
Organization of professional work and	Planning
Diverse and contradictory requirements of professional work	Organization of professional work and Professional ethic

Sources: Petersen and Rauner (1995), Lindberg (2003, 46 ff)

– *Methods and techniques:* "Each vocation uses basic methods and techniques across many areas of the vocation."
– *Planning:* "In planning, two competences are essential: sensualised idea of the task, and an ability to organize the work. A sensualised idea of the task is about shaping the work."
– *(Professional) Ethic:* "Ethics related to the interaction between the quality aspects of the vocation and to be a representative of the vocation."

When these dimensions of professional knowledge are compared with those identified by the ITB during the development of a work-related curriculum concept in the 1990s (Rauner 1996, 96 f.), the similarities are striking (Table 2.1).

This emphasizes the relevance of a competence diagnostic that is based on the concepts of work process orientation and shaping orientation in vocational education and training.

2.2 The Training Objective: Professional Aptitude, Acting Competence, and Shaping Competence

Leaving aside the variety of qualification paths for occupation-based skilled work, the characteristic they have in common (their "unique selling point") is the objective "to learn an occupation". The successful completion of a vocational training programme is identified by the fact that the trainees have attained vocational aptitude, that is, they are capable of exercising the trade they have learned in accordance with the rules and standards of the profession or occupation in question. The occupational profiles (curricula) define in a more or less formalized way what skills have to be expected from a vocationally qualified person. This definition of vocational education entails that in principle "learning in professional work processes" must be a part of the training process. The same is true of the reflection and communication of the work experience as well as the organization and generalization of the professional knowledge acquired. Therefore, the dual organization of vocational education is not a specialty of the VET systems in the German-speaking

countries, but a fundamental trait of vocational education. In the practice of vocational education two versions exist:

– One-phase or integrated duality
– Two-phase or alternating duality

In higher education, the alternating type of duality is dominating. The development of a large number of dual degree programmes as well as pilot projects of a one-phase training for teachers or lawyers show that the duality of vocational education has some standing in higher education, too.

A degree programme in one of the academic professions is traditionally followed by an "apprenticeship", e.g., in the form of a preparatory service (*Referendariat*) for teachers or lawyers. Medical doctors have to undergo a similar type of practical training. In other professions, the dual organization of the qualification process is less formalized. The same is true of school-based vocational education and training.

The idea that an occupation has to be learned on the basis of work processes is the key to the formulation of a criterion for the validity of test assignments.

The point of reference for the development of test assignments is the occupational profile together with the characteristic professional work tasks included therein. These tasks have to be identified with the help of expert-workers workshops whenever the empirical foundation of the parts of the occupational profile is insufficient as a basis for a curriculum that is to be organized according to learning areas and learning areas. The validity criterion for test assignments thus does not consist in a curriculum, but in the developmental tasks that characterize an occupation and in the developmental logic of a vocational education that has to be described by successive steps of development. Therefore, a curricular validity with regard to existing curricula is not aimed at because the formulation of training curricula is not based on the paradigm of developmental logic as exemplified by the concept of situated learning (Lave and Wenger 1991). The advantage is that the diagnostic concept outlined here makes it possible to identify the strengths and weaknesses of different VET models and structures – including the underpinning curricula.

What needs to be taken into account here is how the same or similar occupations are described in different countries through occupational profiles. These profiles typically include a brief description of the essential professional tasks. There is no international norm for the description of occupational profiles. According to the established rules that apply in the German case, the items of the occupational profile describe the skills that are expected in some 10–20 areas of professional practice at the end of the training.

The example of the World Skills shows that the juries, which are composed of experts and practitioners from different countries, have no particular difficulty in reaching a consensus on the test assignments that have to be solved by the participants in the contest. Obviously the jury members have largely identical conceptions of the standards by which the performance of the participants has to be assessed, even though the formal structures on which the description of occupational profiles is based vary from one country to the next. This can be attributed above all to the commonalities of the jurors' professional experience in their international

"communities of practice", which roughly correspond to what is styled "workplace curriculum" by Steven Billett and "learning curriculum" by Lave and Wenger (Billett 2006; Lave and Wenger 1991, 94 ff.). What characterizes an "electrician" and what skills can be expected from him or her is known among the professionals, and this knowledge is independent from any changes that might take place in the national regulations, occupational titles, or training contents. The reason is that the point of reference for the development of test assignments and the definition of standards is the professional character of skilled work and not the curricular organization of VET programmes.

The advantage of this definition of professional validity (as opposed to curricular validity) is that international comparative assessments can also include countries where vocational education is organized according to the model of two-phase – alternating – duality. In this model, the first (i.e., the school-based) phase of the training programme is organized on the basis of vocational subjects and disciplines. The linkage of the contents to the "work process knowledge" of specific occupations is varying. In the second phase of alternance training, which is more or less formalized, the future skilled workers undergo a "practical" familiarization with their occupations.

In Germany, vocational education and training follows the concept of shaping oriented vocational education. In 1991, the Conference of Ministers Responsible for Education and Cultural Affairs (KMK) adopted this concept in the agreement on vocational schools (KMK 1991; Rauner 1988). It was further specified in the guidelines for the development of learning areas in the context of work process oriented curricula (KMK 1996a, b). The learning objective of "ability of co-shaping the world of work with a sense of social acceptability and ecological compatibility" has been fixed in all (framework) curricula since then as an overarching goal of vocational education. The implementation of this shift of perspective in vocational pedagogy has been the topic of several pilot projects since the early 1980s (Heidegger et al. 1997).

The practical implementation takes place in the contents and forms of vocational curricula as well as in guidelines for the organization of training processes (Howe and Heermeyer 2000). Work processes and the contents of work are viewed as compromises between technological opportunities and the economic, social, and ecological interests and values held by the institutions and actors who determine the work process. The ability to take part in shaping the world of work also means that learning and teaching methods have to be developed which give the trainees opportunities to plan, explore, and experiment according to the model of explorative and experimental learning. In doing so, trainees are expected to exploit the full room for maneuver in the solution of work and learning tasks. It is essential that the learning and work results are evaluated on the basis of the criteria developed by the trainees themselves for their projects. This principle includes the concept of complete professional action, which has been developed in labor studies as part of more "human" work and as an alternative to partial and fragmented work tasks (Ulich 1994, 161; Hellpach 1922, 27; Rice 1958; Emry 1959). This groundbreaking concept from labor studies made its way into VET research and practice since the

1980s (Pampus 1987). The implementation and dissemination of shaping oriented vocational education remains a constant challenge for the practice of training. The consequences for the pedagogy of vocational education are far-reaching:

– The work process and the contents of work are taken as the point of reference for the contents of vocational education in a shaping-oriented perspective.
– The planning and evaluation of learning and working projects suggests an evaluation concept to be developed in collaboration with the trainees that enables the latter to evaluate their results according to criteria of economic rationality as well as social and environmental compatibility (Heidegger et al. 1997).

The integration of this principle into the objectives and planning activities of vocational education and training as well as its implementation in pilot projects is also a sign of the establishment of participative types of organizational development, which indicates a fundamental structural change of the world of work since the 1970s (cf. Kern and Schumann 1984). Moreover, the paradigm of shaping orientation has always been a guiding principle of pedagogy. One example is Howard Gardner, who comments on the topic from the point of view of his intelligence research:

> I want my children to understand the world, but not just because this world is fascinating and the human mind is driven by curiosity. My wish is that their insights enable them to change the world so that humans can lead a better life (Gardner 2002, 217).

Without these dimensions of acting and shaping competence, a model of professional competence development would be incomplete. "Action" is a fundamental category of work psychology and pedagogy and refers to the concept of *complete professional action* (Hacker 1998; Volpert 2005). The latter includes the activities to be performed and also the preparatory steps as well as the evaluation of the results according to criteria that are derived from the diverse and sometimes contradictory requirements of the concrete work tasks to be solved.

The expectation implicitly associated with professional acting competence is that the competent person is not only capable of carrying out work tasks *completely*, but also of reflecting and evaluating his or her professional activities in their professional and social context. This means that a professional activity is always performed in a work context whose manifold relevance can also be identified and evaluated by the individual.

When the steps of a complete professional activity are related to the criteria of a *holistic solution of professional tasks*, the concept of complete professional action is transformed into the category of *complete (holistic) problem solving*, which is fundamental for the design of vocational training processes and the modeling of professional competence. In addition to the concept of complete professional action, this requires a justification of the criteria that are formulated for the holistic solution. These demands are derived from the objective circumstances and the subjective expectations concerning the content and organization of work in society (Fig. 2.3).

Eight requirements are formulated for the performance and solution of professional tasks (see Sect. 3.2 for details). In each specific case, the skilled workers have to consider whether all or a subset of these requirements are relevant for the task in

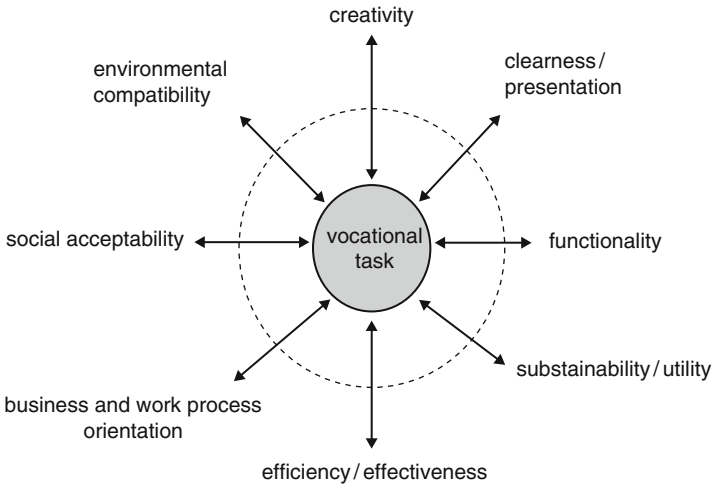


Fig. 2.3 Criteria for the complete (holistic) solution of professional tasks

question. For instance, the legislation concerning the use of energy-efficient lamps has immediate effects on the planning and installation of electric lighting equipment. In the case of heating equipment, it is not only the variety of heating methods that constitute the objective conditions but also the legal requirements concerning environmental compatibility, safety, and energy efficiency of heating devices in the specific situation. The objective conditions, together with the subjective expectations of customers with regard to utility, sustainability, and aesthetics as well as the subjective interests of the employees with regard to their working conditions, constitute a solution space in which the specific solutions to professional work tasks can be situated. The eight criteria make it possible to define professional competence in terms of content with a view to a holistic concept of action and shaping.

The requirements that are formulated for the complete (holistic) solution of professional tasks are also the components of the requirement dimension in the competence model for vocational education (see Chap. 3). The objective of domain-specific qualification research is to investigate which demands and contents are taken into consideration in the performance of professional work tasks, how these demands and contents are prioritized, and how the requirements can be described as a domain-specific qualification and competence profile. This is the basis for the description of solution spaces for professional work tasks.

2.3 Professional Competence Development

Vocational education is understood not as an activity directed at the impartation of subjects or contents, but as a process of developing professional acting and shaping competence. The concept of professional competence development requires an

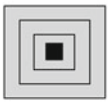
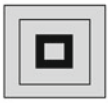
Learning areas			Working tasks	problem- solving
(4) Experiential, systematic in-depth knowledge	How to relate knowledge to changing contexts.		Unpredictable work-based problems	experience-based and intuitive (non-deterministic) problem-solving
(3) Detail and functional knowledge	What is important in detail and how things operate.		Problem-based special working tasks	Theory based (non-deterministic) problem-solving
(2) Integrated, professional knowledge	Why and how things are related the way they are.		Systematic working tasks	Systematic, rule-guided problem-solving
(1) Orientation and overview knowledge	The occupation's main content.		Career guided oriented working tasks	Guided (deterministic) problem-solving

Fig. 2.4 The developmental structure of vocational curricula (Rauner 2004, 45)

organization of the contents in vocational training programmes on the basis of subject theory.

The concept of the *developmental structure of vocational education and training programmes* (Benner 1995; Blankertz 1983; Bremer 2004; Dreyfus and Dreyfus 1988; Gruschka 1985; Rauner 1999), which is widely acknowledged in expertise research and vocational pedagogy, is another important element of a modern vocational education. The development of professional competence through the medium of the learners' work on professional tasks that have the quality of developmental tasks (Havighurst 1972) is of utmost importance for competence development. This requires qualification research to identify the characteristic professional work tasks with the aim to organize them according to developmental logic. The normative momentum of this type of vocational education is expressed by a didactic concept that includes four areas of learning which are arranged in a logical sequence (cf. Fig. 2.4; Table 2.2).

These areas integrate the tasks and competences of beginners, advanced learners, professionals, and experts. Apart from the professional work tasks they also describe the educational objectives that specify under what aspects the work tasks and situations have to be made a topic of vocational education.

Figure 2.4 shows the four learning areas that build upon one another according to development theory:

– Knowledge for orientation and overview/orienting work tasks
– Integrated knowledge/systemic work tasks
– Knowledge of details and functions/problem-oriented, special work tasks
– Experiential and systematic in-depth knowledge/unpredictable work tasks

Table 2.2 The four developmental areas according to which VET programmes can be organized on the basis of developmental logic

Developmental area 1: orienting work tasks – knowledge for orientation and overview
Job starters already have some prior experience and knowledge with regard to their occupation, which they selected not the least on the basis of this prior knowledge. At the beginning of their training they are introduced to orienting work tasks that give them an opportunity to gain an overview of the work in this occupation. Novices work on these tasks systematically and in accordance with existing rules, prescriptions and quality standards. This first learning area is thus characterized by the acquisition of professional knowledge for orientation and overview that allows the trainees to become aware of the structure of the training occupation from a professional perspective. At the same time they experience the diverse requirements of work processes and the integration of these processes into the development and innovation processes in the enterprise. Work and technology are thus experienced also as phenomena that can be structured by the people involved.
Developmental area 2: systemic work tasks – integrated professional knowledge
The advanced beginner, who already has concrete ideas of the occupation from the perspective of application and utilization and who has acquired some relevant competences, now encounters systemic work tasks for the development of integrated professional knowledge (perspective of systems architecture). The relationship and interaction of skilled worker, technology, and work organization also requires an integrated view. The mastering of systemic tasks means that the trainees fulfill these tasks with a view to the context and in consideration of the systemic structure of technology and work organization. At this second level of vocational learning, the basic concept of the occupation formulated at the first level and the integrated professional knowledge can lead to a reflected professional identity when the educational potentials of the corporate work environment are exploited.
Developmental area 3: problem-oriented special work tasks – knowledge of details and functions
The professional knowledge for orientation and overview, the integrated knowledge, and the ability to solve tasks systematically enable the trainees at the third level to work on problem-oriented special work tasks. The solution of these tasks is no longer possible on the basis of pre-defined rules and patterns. The task includes some novelty that is not fully covered by the problem solving strategies applied to former tasks. The trainees need to analyse the task first and to identify the problem in order to plan their activities.
The paradigm of the holistic and complex work activity, which was developed in the 1980s, and the associated capacity of independent planning, implementation, control, and evaluation of professional work tasks, corresponds to the third step of the logical structuring of vocational education. At this level, the professional identity leads to professional responsibility as a condition for performance (intrinsic motivation) and quality awareness as an essential condition for the fulfillment of complete work tasks in problematic work contexts.
Developmental area 4: unpredictable work tasks – experiential and systematic in-depth knowledge
When the trainees have developed a sufficient understanding of the tasks of professional work, they can gain experience with the handling of non-routine situations and problems. Unpredictable work tasks that are too complex to be fully analyzed in the concrete work situation so that they cannot simply be mastered systematically put high demands on the trainees on their way to the level of competent professionals. Competence in this case is based on knowledge about previous tasks where the constellation was at least similar, on the anticipation of possible strategies, on theoretical knowledge and practical skills as well as on intuition. Problems are solved in a situative way without the necessity to calculate the activity with all its preconditions and consequences in detail.
The aim at the fourth level of this model of vocational education is to integrate reflected professionalism with subject-specific competence in order to open the opportunity for higher education. The aptitude for higher education emerges from an extended self-conception which is not so much rooted in a narrowly defined occupational profile, but rather in a career path that is associated with this occupation.

Source: Rauner (1999, 436 ff)

The contents of Fig. 2.4 are explained in detail in Table 2.2.

Professional development is considered as an integrated process of competence and identity development. Professional competence development, according to this view, takes place in a process of developing one's professional identity through integration into the relevant professional community of practice (Lave and Wenger 1991). During this process, quality criteria are internalized as a basis of professional activity and decision making. The "assessment" of professional competence development requires the development of evaluation tasks that make it possible to follow up the emergence of the subjective representations of these criteria.

The justification of the concept of developmental areas is based on the novice-expert paradigm from cognitive psychology, which has considerably influenced expertise research and made its way into development theoretical (vocational) education research (Fischer et al. 1995; Gruber and Ziegler 1996). The crucial momentum of professional development is the reflected work experience (cf. above all Schön 1983). The paradigmatic relevance of the novice-expert model is based, on the one hand, on development and learning theories like

- Situated learning and the "community of practice" (Lave and Wenger 1991),
- The theory of "cognitive apprenticeship" (Collins et al. 1989),
- The development theory by Havighurst and its application in educational and VET research (Havighurst 1972; Gruschka 1985; Blankertz 1983; Terhart 1998; Rauner 2007a, c)

and on the other hand on expertise research, whose models of phased competence development all follow the novice-expert paradigm. Vocational education and training research was thus challenged to deal with the developmental approach. Since the 1970s, educational research on the basis of development theory is one of the pillars of curriculum design and curriculum research (Aebli 1963; Bruner 1977; Lenzen 1973; Fischer et al. 1995). The developmental paradigm emerged step by step in the scientific monitoring of pilot projects (Blankertz 1986; Girmes-Stein and Steffen 1982; Bremer and Haasler 2004) and in the course of extensive empirical studies on the development of competence in educational and healthcare occupations.

The COMET project thus situates itself within the large number of empirical studies that have confirmed the novice-expert paradigm in many different ways and developed this model into a fundamental concept of expertise, competence, and curriculum research. The aim is also to contribute to the advancement of the methodology of VET research. Competence development as a topic of competence diagnostics refers to research problems, methods, and results that cannot escape the inseparable relation between intentionality (normativity) and empirical facts. The concept of the developmental organization of vocational learning processes and programmes can be taken as a basis for the modeling and assessment of professional competence and identity development (see also Messner and Reussner 2000; Terhart 1998).

2.4 Professional Identity and Occupational Commitment

Professional identity and occupational commitment undoubtedly are a rich field of empirical VET research with regard to competence assessment. This is so because the two categories represent relevant dimensions of the ways employees relate themselves to their work. This relation constitutes the subjective side of the work process as opposed to the objective dimension, which is represented by the work tasks and the associated qualification requirements.

Professional identity is the result of a development process that is closely linked to the development of professional competence. Strictly speaking the development of professional identity is one particular dimension of professional competence development.

Following Havighurst's theory of developmental tasks, a German school project in the early 1980s developed an evaluation concept for the training of kindergarten teachers. The competence and identity development of prospective kindergarten teachers was described and evaluated on the basis of four developmental tasks. The description of these four characteristic developmental tasks already shows how the process of competence development is inseparably linked to the development of professional identity. For instance, the second developmental task (concept of pedagogical perception of others) is characterized as follows:

> Having acquired a professional role model the student can now prepare for his first internships. Up to then he already had some contact with little children, but now he is insecure because he asks himself whether his behaviour on these occasions had been pedagogically appropriate. As a consequence of this shift of perspective he reflects his perception of children since he wants to be sure that his behaviour towards them is pedagogical. It is only when he has succeeded in working out a concept of pedagogical perception of others that he regains his self-reliance in the new role of a kindergarten teacher (Gruschka 1983, 146).

In the outline of this curriculum and evaluation concept, Andreas Gruschka pointed out an important research gap:

> Both curriculum planners and their critics never demonstrated how the student responds to the content of the educational programme in question and how he internalizes them in such a way that professional competence development can be accompanied by the development of professional identity (Gruschka 1983, 143).

As discussed in the previous section, the assessment of professional competence has to be organized on the basis of the work process and with reference to the training objective of professional acting competence. Accordingly the consideration of subjective dispositions and motivations is indispensable. The methodology outlined here links the relevant phases in the development of professional identity during the training process to the corresponding levels and dimensions of professional competence.

Walter Heinz refers to another aspect of identity development, namely, the shaping of one's own biography:

> In the industrial service society the focus of professional socialisation processes […] shifts from socialisation (in the sense of learning conventional social roles) to individualisation. For the professional socialisation this means that the internalisation of professional norms is gradually replaced by the formulation of subjective claims with regard to the content of work and the active shaping of professional biographies (Heinz 1995, 105).

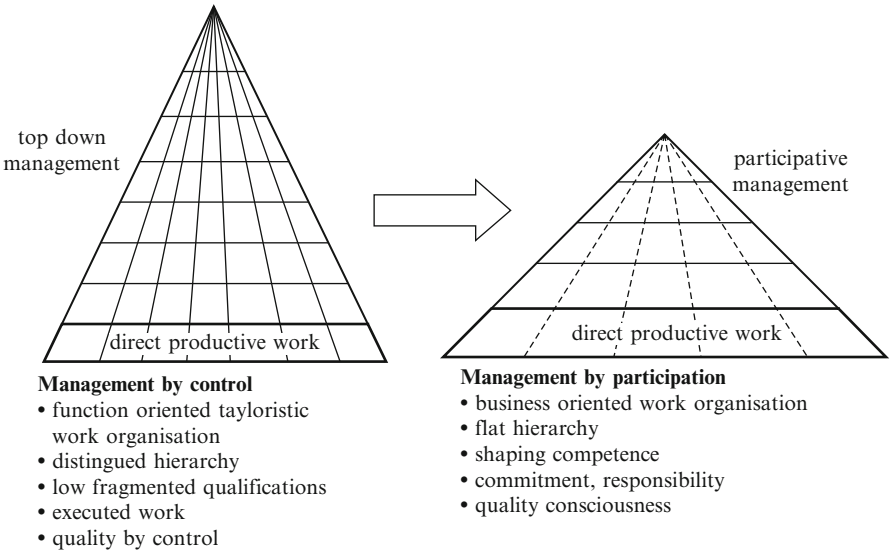


Fig. 2.5 From functional orientation to business process orientation in the organizational structure (Source: Rauner 2007b, 21)

Research in vocational pedagogy as well as socialization research thus suggests that the development of professional identity has to be viewed as a dimension of the development of professional competence, and to be integrated into a model of competence development.

It has to be expected that the development and the characteristics of this identity are influenced by several different factors. On the one hand, these would be factors that result from the training occupation and the way the training is organized (training workshop, learning in the work process, etc.) (cf. Lempert 2004). With regard to international comparative studies, one would also have to consider that identity varies according to the different types of vocational education and training systems, e.g., in Germany, Japan, and the USA. The details of the relationship between professional identity, commitment, and competence development are studied empirically in the context of the COMET project.

Occupational *commitment*, irrespective of its shaping by the professional identity or the feeling of loyalty to a particular enterprise, is a fundamental requirement for productive and competitive organizational structures (cf. Fig. 2.5). This means that "motivation" is a core objective of vocational education and training. General and vocational education are fundamentally different in this respect. From the point of view of general education, motivation is predominantly an intervening variable in the learning process and therefore a topic of learning research. In VET research, the motivational aspect of professional commitment and performance orientation is viewed as a dimension of the analysis and organization of vocational learning processes. This dimension is as important as competence development. The quality awareness and the associated behavior that emerge from occupational commitment are a prerequisite for the implementation of lean organizational structures in the company.

This requires broadband training occupations as well as high-quality training. A prerequisite of quality awareness and occupational commitment is a high degree of identification with the profession as well as opportunities for independent professional activities and decision-making that challenge the sense of responsibility. Competence diagnostics therefore depends on a method that makes it possible to measure the degree of occupational commitment as exactly as possible and to get information about the context variables on which occupational commitment is dependent. To this end a variety of scales have been developed based on findings from industrial sociology and commitment research. If these diagnostic tools are applied at different moments of the training process and one connects these investigations with competence diagnostics, the research findings deliver information about

– The development of professional identity and occupational commitment in connection with the development of professional competence
– The organization and design of professional learning and development processes that support the development of professional identity and occupational commitment

When this methodology is chosen, the necessity to integrate the concepts of identity development and commitment into the competence model is avoided. The development of professional competence and professional identity as well as occupational commitment is viewed as interrelated but nevertheless distinct variables that are measured in different ways. This pragmatic approach has a considerable methodological advantage. It is drawing on a rich tradition of the assessment of occupational commitment in organizational psychology, management research, industrial sociology, and VET research. The findings are integrated in the COMET research agenda, but have not to be integrated into the procedure of competence measurement itself.

As regards the commitment of trainees, it is not so much the quantitative strength of commitment that the COMET project is interested in, but rather the question on which *normative fields* this commitment is focusing. For the operationalization of this question, a number of different "types" of commitment were identified. For instance, commitment can be sustained by identification with the company or with the profession, or by a work ethic that is independent from the particular contents of professional work. We summarized the debates in the relevant literature and explained the details of the identification of the different types elsewhere (Heinemann and Rauner 2008). In this place a brief account shall be sufficient.

The commitment of employees is studied in two different schools of thought. On the one hand, the sociology of work, particularly in the 1980s, conceptualized different subjective attitudes towards work among other things as a contrast of work ethic and professional ethic (Jäger et al. 1987; Jäger 1989). On the other hand, management and behavioral research (especially in the USA) have carried out empirical investigations of different forms of "commitment" since the 1950s.

Organizational and occupational commitment, that is, identification with the company or the occupation respectively, are predominantly affective bonds whose expected outcome is motivation in the professional work.

Although the research interest in commitment research was targeted primarily at organizational commitment (Porter et al. 1974; Mathieu and Zajac 1990; Meyer and Allen 1991), Aaron Cohen, in a recent study on the dynamics between occupational and organizational commitment in flexible labor markets (Cohen 2007), identifies the "occupational" commitment that emerges from the professional form of work as a theoretical framework that influenced commitment research from the very beginning. This goes back to one of the first typologies on professional commitment by Becker and Carper (1956). This research is based on the concept of professionalism and thus on the extent to which individuals identify with their profession and internalize its values.

The extent of such a commitment in the context of the attitudes towards work in general is measured by the "Protestant Work Ethic Scale" and the "Job Involvement Scale" (Kanungo 1982). In this line of quantitative assessment of commitment and following, the terminology of the instrument most frequently used – the "Organizational Commitment Questionnaire" (OCQ) developed by Porter and Smith (1970) – the term "organization" was replaced with "occupation" with a view to investigating the attitudes towards the profession. A significant step in this development are the studies by Blau (1985, 1988),

> who defined career commitment as one's attitude to one's profession or vocation […]. In a later study, Blau, Paul and St. John (1993, 311) developed a revised occupational commitment scale intended to fit better with the other scales of commitment forms […]. In this scale, occupational commitment was defined as 'one's attitude, including effects, beliefs, and behavioural intention towards his/her occupation' (quoted from Cohen 2007).

Cohen draws the conclusion that it is crucial for understanding the commitment of employees in the work process to investigate the relationship between organizational and occupational commitment, and that this point should be paid more attention in commitment research.

> First, the role that vocational and educational training (VET) plays in a society may very well affect the concept of commitment. In North America, such training is held in relatively low esteem. In many European countries, however, vocational educational is prized, and commitment to one's vocation may be as significant in these cultures as commitment to the organization is in North America. In Germany, Austria, Switzerland, or Australia, for example, apprenticeships are important tools for training a large portion of the workforce for their occupational career. Such training, along with earlier socialization, helps inculcate basic work values in its students (Ertl 2000; Rauner 2004). […] All the above suggests that in many European countries occupational commitment might be as important as organizational commitment (Cohen 2007, 3).

On this basis there is the opportunity, from the point of view of vocational pedagogy, to investigate the connection of vocational education, professional identity development, and occupational commitment with the help of appropriate scales. This, however, requires that the commitments in question are no longer conceptualized as reciprocal ties between employees and organization (or even as responses of staff to motivational measures by management), but viewed in the context of the development of professional identity. This new orientation of the empirical tools of commitment research makes it possible to link commitment to the development of professional competence.

References

Aebli, H. (1963). *Psychologische Didaktik. Didaktische Auswertung der Psychologie von Jean Piaget*. Stuttgart: Klett-Cotta.

Bannwitz, A., & Rauner, F. (Hrsg.). (1993). *Wissenschaft und Beruf. Berufliche Fachrichtungen im Studium von Berufspädagogen des gewerblich-technischen Bereiches* (Berufliche Bildung 17). Bremen: Donat.

Becker, H. S., & Carper, J. W. (1956). The development of identification with an occupation. *American Sociological Review, 32*, 341–347.

Benner, P. (1995). *Stufen zur Pflegekompetenz. From Novice to Expert*. Bern: Hans HuberVerlag.

Billett, S. R. (2006). Constituting the workplace curriculum. *Journal of Curriculum Studies, 38*(1), 31–48.

Blankertz, H. (1983). Sekundarstufen II – Didaktik und Identitätsbildung im Jugendalter. In D. Benner, H. Heid, & H. Thiersch (Hrsg.), *Beiträge zum 8. Kongress der Deutschen Gesellschaft für Erziehungswissenschaft* (ZfPäd, Beiheft 18, pp. 139–142). Weinheim: Beltz.

Blankertz, H. (Hg.). (1986). *Lernen und Kompetenzentwicklung in der Sekundarstufe II. Abschlussbericht der wissenschaftlichen Begleitung Kollegstufe NW, 2Bde*. Soest: Soester Verlagskontor.

Blau, G. J. (1985). The measurement and prediction of career commitment. *Journal of Occupational Psychology, 58*, 277–288.

Blau, G. J. (1988). Further exploring the meaning and measurement of career commitment. *Journal of Vocational Behaviour, 32*, 284–297.

Blau, G. J., Paul, A., & St. John, N. (1993). On developing a general index of work commitment. *Journal of Vocational Behaviour, 42*, 298–314.

Brandstädter, J. (1984). Entwicklung in Handlungskontexten: Aussichten für die entwicklungspsychologische Theorienbildung und Anwendung. In H. Lenk (Hrsg.), *Handlungstheorien – interdisziplinär* (Bd. 3, pp. 848–878). München: Wilhelm Fink Verlag.

Bremer, R., & Haasler, B. (2004). Analyse der Entwicklung fachlicher Kompetenz und beruflicher Identität in der beruflichen Erstausbildung. *Zeitschrift für Pädagogik*, *2*, 162–181. Weinheim: Beltz.

Bruner, J. S. (1977). Wie das Kind lernt, sich sprachlich zu verständigen. *Zeitschrift für Pädagogik*, *23*, 153 ff.

Bybee, R. W. (1997). *Achieving scientific literacy: From purposes to practices*. Portsmouth: Heinemann.

Carlgren, I. (1999). Schoolwork as a certain kind of practice. In I. Carlgren (Ed.), *Environments for learning* (pp. 102–132). Lund: Studentliteratur.

Cohen, A. (2007). *Dynamics between occupational and organizational commitment in the context of flexible labour market: A review of the literature and suggestions for a future research agenda* (ITB Forschungsbericht 26/2007).

Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing and mathematics. In L. B. Resnick (Ed.), *Knowing, learning, and instruction. Essays in honour of Robert Glaser* (pp. 453–494). Hillsdale: Erlbaum.

Dreyfus, H. L., & Dreyfus, S. E. (1988). *Mind over machine: The power of human intuition and expertise in the era of the computer*. New York: The Free Press.

Emry, F. E. (1959). *Characteristics of socio-technical systems* (Document No. 527). London: Tavistock Institute of Human Relations.

Engeström, Y. (2001). Expansive learning at work: Towards an activity theoretical reconceptualisation! *Journal of Education and Work, 14*, 133–156.

Engeström, Y., & Cole, M. (1993). A cultural-historical approach to distributed cognition. In G. Salomon (Ed.), *Distributed cognitions. Psychological and educational considerations* (pp. 1–46). Cambridge/New York: Cambridge University Press.

Ertl, H. (2000). *Modularisation of vocational education in Europe: NVQs and GNVQs as a model for the reform of initial training provisions in Germany*. Wallingford: Symposium Books.

Fischer, M., Jungeblut, R., & Römmermann, E. (1995). *„Jede Maschine hat ihre eigenen Marotten!". Instandhaltungsfacharbeit in der rechnergestützten Produktion und Möglichkeiten technischer Unterstützung*. Bremen: Donat Verlag.

Gardner, H. (2002). *Intelligenzen. Die Vielfalt des menschlichen Geistes*. Stuttgart: Klett-Cotta.

Girmes-Stein, R., & Steffen, R. (1982). *Konzept für eine entwicklungsbezogene Teilstudie im Rahmen der Evaluation des Modellversuchs zur Verbindung des Berufsvorbereitungsjahres (BVJ) mit dem Berufsgrundschuljahr (BGJ) an berufsbildenden Schulen des Landes NW*. Münster: Zwischenbericht.

Gruber, H., & Ziegler, A. (1996). *Expertiseforschung*. Opladen: Westdeutscher Verlag.

Gruschka, A. (1983). Fachliche Kompetenzentwicklung und Identitätsbildung im Medium der Erzieherausbildung – über den Bildungsgang der Kollegschule und zur Möglichkeit der Schüler, diesen zum Thema zu machen. In D. Benner, H. Herd, & H. Thiersch, (Hrsg.), *Zeitschrift für Pädagogik 18. Beiheft: Beiträge zum 8. Kongreß der Deutschen Gesellschaft für Erziehungswissenschaft* (pp. 142–152). Weinheim: Beltz.

Gruschka, A. (1985). *Wie Schüler Erzieher werden. Studie zur Kompetenzentwicklung und fachlichen Identitätsbildung in einem doppelqualifizierenden Bildungsgang des Kollegschulversuchs NW*. Wetzlar: Büchse der Pandora.

Hacker, W. (1998). *Allgemeine Arbeitspsychologie*. Bern: Hans Huber Verlag.

Havighurst, R. J. (1972). *Developmental tasks and education*. New York: David Mc Kay Company (Erstausgabe 1948).

Heidegger, G., Adolph, G., & Laske, G. (1997). *Gestaltungsorientierte Innovation in der Berufsschule. Begründungen und Erfahrungen*. Bremen: Donat.

Heinemann, L., & Rauner, F. (2008). *Identität und Engagement: Zur Konstruktion eines Instruments zur Beschreibung der Entwicklung beruflichen Engagements und beruflicher Identität* (A+B Forschungsberichte 01/2008). Bremen/Heidelberg/Karlsruhe.

Heinz, W. R. (1995). *Arbeit, Beruf und Lebenslauf. Eine Einführung in die berufliche Sozialisation. Grundlagentexte Soziologie*. Weinheim/München: Juventa.

Hellpach, W. (1922). Sozialpsychologische Analyse des betriebswirtschaftlichen Tatbestandes 'Gruppenfabrikation'. In R. Lang & W. Hellpach (Hrsg.), *Gruppenfabrikation* (pp. 5–186). Berlin: Springer.

Hirst, P. (1974). *Knowledge and curriculum. A collection of philosophical papers*. London/Boston: Routledge and Kegan Paul.

Howe, F., & Heermeyer, R. H. H. (2000). *Lern- und Arbeitsaufgaben für eine gestaltungsorientierte Berufsbildung*. Bremen.

ITEA (International Technology Association). (2003). *Standards für eine allgemeine technische Bildung* (von G. Höpken, S. Osterkamp, & G. Reich, deutsche Übersetzung). Villingen-Schwenningen: Neckar-Verlag.

Jäger, C. (1989). Die kulturelle Einbettung des Europäischen Marktes. In M. Haller, H.-J. Hoffmann-Novottny, & W. Zapf (Hrsg.), *Kultur und Gesellschaft* (pp. 556–574). Frankfurt/Main: Campus Verlag.

Jäger, C., Bieri, L., & Dürrenberger, G. (1987). Berufsethik und Humanisierung der Arbeit. *Schweizerische Zeitschrift für Soziologie*, *13*(1), 47–62. Zürich: Seismo Press.

Kanungo, R. N. (1982). *Work alienation: An integrative approach*. New York: Praeger Publishers.

Kern, H., & Schumann, M. (1984). *Das Ende der Arbeitsteilung? Rationalisierung in der industriellen Produktion*. München: Beck.

KMK – Kultusministerkonferenz (Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland). (Hg.). (1991). Rahmenvereinbarung über die Berufsschule. Beschluss der Kultusministerkonferenz vom 14./15.3.1991. *Zeitschrift für Berufs- und Wirtschaftspädagogik*, *7*, 590–593. Bonn.

KMK – Kultusministerkonferenz (Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland). (Hg.). (1996a). *Handreichungen für die Erarbeitung von Rahmenlehrplänen der Kultusministerkonferenz für den berufsbezogenen Unterricht in der Berufsschule und ihre Abstimmung mit Ausbildungsordnungen des Bundes für anerkannte Ausbildungsberufe*, Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland, Bonn.

KMK – Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland. (Hg.). (1996b). *Überlegungen der KMK zur Weiterentwicklung der Berufsausbildung*. Bonn.

Lave, J., & Wenger, E. (1991). *Situated learning. Legitimate peripheral participation*. New York/ Cambridge: Cambridge University Press.

Lempert, W. (2004). *Berufserziehung als moralischer Diskurs*. Baltmannsweiler: Schneider.

Lenzen, D. (1973). *Didaktik und Kommunikation*. Frankfurt/Main: Athenäum.

Lindberg, V. (2003). Vocational knowing and the content in vocational education. *International Journal of Training Research, 1*(2), 40–61.

Mathieu, J. E., & Zajac, D. M. (1990). A review and meta-analysis of the antecedents, correlates and consequences of organizational commitment. *Psychological Bulletin, 108*, 171–194.

Messner, H., & Reussner, K. (2000). Die berufliche Entwicklung von Lehrpersonal als lebenslanger Prozess. *Beiträge zur Lehrerbildung*, *18*(2), 157 ff.

Meyer, P. J., & Allen, N. J. (1991). A three-component conceptualization of organizational commitment. *Human Resource Management Review, 1*, 61–89.

OECD (Organisation for the Economic Co-operation and Development). (1999). *Measuring students' knowledge and skills: A new framework for assessment*. Paris: OECD.

Pampus, K. (1987). Aufsätze zur Weiterentwicklung betrieblicher Ausbildungsmethoden. *BWP 16*, Bd. 2, 43–51.

Petersen, W. (1996). Berufs- und Fachdidaktik Elektrotechnik im Studium von Berufspädagogen. In A. Lipsmeier & F. Rauner (Hrsg.), *Beiträge zur Pädagogik für Schule und Betrieb* (pp. 103–141). Karlsruhe: Holland+Josenhaus.

Petersen, W., Rauner, F. (1995). *Evaluation und Weiterentwicklung der Rahmenlehrpläne des Landes Hessen Berufsfelder Metall- und Elektrotechnik* (ITB-Arbeitspapier 15). Bremen: ITB.

Porter, L. W., & Smith, F. J. (1970). *The etiology of organizational commitment*. Irvine: University of California, unveröffentlichtes Manuskript.

Porter, L. W., Steers, R. M., Mowday, R. T., & Boulian, P. V. (1974). Organizational commitment, job satisfaction, and turnover among psychiatric technicians. *Journal of Applied Psychology, 59*, 603–609.

Rauner, F. (1988). Die Befähigung zur (Mit)Gestaltung von Arbeit und Technik als Leitidee beruflicher Bildung. In G. Heidegger, P. Gerds, & K. Weisenbach (Hg.), *Gestaltung von Arbeit und Technik – ein Ziel beruflicher Bildung* (32–50). Frankfurt am Main/New York: Campus.

Rauner, F. (1996). Elektrotechnik-Grundbildung. Zu einer arbeitsorientierten Gestaltung von Lehrplanen im Berufsfeld Elektrotechnik. In A. Lipsmeier & F. Rauner (Hrsg.), *Beitrage zur Fachdidaktik Elektrotechnik*. Stuttgart: Holland und Josenhans.

Rauner, F. (1999). Entwicklungslogisch strukturierte berufliche Curricula: Vom Neuling zur reflektierten Meisterschaft. *Zeitschrift für Berufs- und Wirtschaftspädagogik (ZBW)*, *95*(3), 424–446. Stuttgart: Franz Steiner Verlag

Rauner, F. (2004). Die Bedeutung des Arbeitsprozesswissens für eine gestaltungsorientierte Berufsbildung. In M. Fischer & F. Rauner (Hrsg.), *Lernfeld: Arbeitsprozess* (pp. 25–52). Baden-Baden: Nomos

Rauner, F. (2007a). *Duale Berufsausbildung in der Wissensgesellschaft – eine Standortbestimmung*. Reihe: Jugend und Arbeit – Positionen. Herausgeber: Bertelsmann Stiftung.

Rauner, F. (2007b). *Kosten, Nutzen und Qualität der beruflichen Ausbildung* (ITB-Forschungsberichte 23/2007). Bremen: Institut Technik und Bildung, Universität Bremen.

Rauner, F. (2007c). Practical knowledge and occupational competence. *European Journal of Vocational Training*, *40*(1), 52–66. Thessaloniki: Cedefop – European Centre for Vocational Training.

Rice, A. K. (1958). *Productivity and social organization. The Ahmedabad experiment*. London: Tavistock Institute of Human Relations.

Ropohl, G. (2004). *Arbeits- und Techniklehre. Philosophische Beiträge zur technologischen Bildung*. Berlin: Edition Sigma.

Säljö, R. (2000). *Lärande i praktiken – ett sociokulturellt perspektiv* [Learning in practice. A sociocultural perspective; in Swedish]. Stockholm: Prisma.

Schön, D. A. (1983). *The reflective practitioner. How professionals think in action*. New York: Harper Collins (Basic Books).

Terhart, E. (1998). Lehrerberuf. Arbeitsplatz, Biografie und Profession. In H. Altrichter, et al. (Hrsg.), *Handbuch der Schulentwicklung* (pp. 560–585). Innsbruck/Weinheim: Studienverlag

Ulich, E. (1994). *Arbeitspsychologie* (3rd ed.). Stuttgart: Schäffer-Poeschel.

Volpert, W. (2005). Arbeitsgestaltung und Arbeitsorganisation. In F. Rauner (Hg.), *Handbuch Berufsbildungsforschung*. Bielefeld: W. Bertelsmann Verlag.

Chapter 3
The COMET Competence Model: Foundations for the Study of Professional Competence and Identity

3.1 Competence Models

The relevance of competence diagnostics on the basis of theoretical models has been emphasized in the debates in educational science at least since the PISA project (Klieme and Leutner 2006). There were already models for a systematic description of competence in the natural sciences (especially Bybee 1997), which inspired the modeling in the PISA project and the learning and teaching research in the field of science education (cf. Schecker and Parchmann 2006, 45; Baumert et al. 2001).

Competence models describe a system of competence dimensions. The latter characterize the cognitive requirements that a learner has to fulfill in order to be able to solve (occupation-specific) tasks and problems. An important development for competence diagnostics in the field of vocational education is the orientation towards *domain-specific* competences. This was initiated above all by the results of international comparative assessments of generic competences like problem solving. Generic competences are closely linked to subject-related competences in a specific domain. This confirms the position that was already formulated by Howard Gardner on the basis of his intelligence studies. According to this research, the capacity for critical reflection, for instance, needs to be learned anew in any new domain, "for each [domain] has its own objects, procedures and modes of connection" (Gardner 2002, 130). According to Jochen Gerstenmaier, expertise research and learning research have refuted the hypothesis that content knowledge is devalued by generic skills like problem solving. This can be viewed as a clear distinction of the notion of competence as defined especially by Hartig and Klieme from concepts that emphasized so-called "key competences" or "key qualifications".

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3.2 Conceptual Clarifications

Competence models can be classified into one-dimensional and multidimensional models. The latter usually do not contain more than four dimensions. *Dimensions* are the overarching structural elements of a competence model. For example, the English national curriculum concept of the QCA (2000) for science education includes the two dimensions (1) "programmes of study" and (2) "levels". The German model for the educational standards for natural sciences features a two-dimensional competence concept as well, but this one can also be interpreted as a three-dimensional model (Schecker and Parchmann 2006, 55).

The dimensions of a competence model are structured by *components*, which define the coordinates of a competence, as it were, in an n-dimensional competence space (Schecker and Parchmann 2006, 53). This definition has a somewhat abundant meaning as it suggests that after the definition and foundation of multidimensional competence spaces with properly selected components there remains only the question of applying the model. In the meantime, the psychometric assessment of competence models has delivered sufficient data to show that the most difficult task in the development of an efficient competence diagnostics lies in the transfer of competence models based on pedagogical and subject-specific theory into measurement models. For example, the problem-solving strategies of students were addressed with multidimensional Rasch models of various degrees of complexity (cf. Rost et al. 2005). The seven process categories (sub-competences) of the German supplementary test for science education (PISA) were integrated in various ways (between 2 and 10 categories). What is remarkable in the interpretation of the results is that the outcomes are rated differently from the perspectives of test psychology, on the one hand, and science education, on the other hand. Whereas the simple model with only two summative categories has a greater explanatory value from the psychometric point of view, which means that the subject-specific aspects are less important for the assessment of competence in this field than the cognitive demands, the science educators hold a different view. Their interest is directed towards a broad representation of the subject-specific contents in the competence model (Schecker and Parchmann 2006, 50).

The question as to whether competence levels should rather be termed *competence distinctions* is interesting for vocational education and training. According to Schecker and Parchmann, the definition of a hierarchy of competence levels has its origins in the political interest in grading. The notion of competence distinction, on the other hand, would allow for a qualitative description of skills that need not necessarily be ranked in an ordinal scale (Schecker and Parchmann 2006, 51). In the COMET competence model, the level of functional competence (first level of professional competence) is not a subordinate or inferior competence, but a competence distinction that has the quality of a basic competence. The lack of functional abilities or their insufficient distinction can neither be compensated by conceptual-processual competences (second competence levels) nor by abilities that belong to the third competence level (see Sect. 3.3).

The question to what extent the competence levels represent competences that build upon each other and to what extent they are competence distinctions must be investigated empirically.

As regards the foundation of competence levels or distinctions, neither psychometrics nor educational theory offers a scientific procedure for determining the number of levels. What is needed is pragmatic and workable solutions that are based on a theoretical framework, on the one hand, and which, on the other hand, provide practitioners with a plausible and easy-to-use differentiation of competence levels. Three to four competence levels are considered as appropriate from this point of view.

The application of stage models as measurement models is in most cases based on Rasch scales of *personal abilities* or *item difficulties*. The latter can largely be excluded for vocational education because the solutions to professional tasks are seldom rated according to criteria of "right" or "wrong", but rather according to criteria that assess the quality of solutions with regard to several competing aspects (see Chap. 4). What is therefore required is a criteria-based *stage concept* that is supported by the theoretical framework discussed in the previous chapter and which makes it possible to describe the attainment of a higher competence level also as a higher level of performance. In vocational education, a strong functional competence is a necessary condition for successful professional conduct, but it is no sufficient predictor of professional action competence.

3.3 The COMET Competence Model

The principles and objectives of vocational education and training as discussed in Chap. 2 can best be represented in a competence model with three dimensions (Fig. 3.1). The COMET competence model distinguishes between

- The requirement dimension (competence levels)
- The content dimension
- The action dimension

3.3.1 The Levels of Professional Competence (Requirement Dimension)

The requirement dimension represents the levels of professional competence that build on top of one another. These competence levels are defined on the basis of skills that are associated with the (holistic) solution of professional work tasks (see Fig. 2.3, Sect. 2.2). The objective and subjective requirements for the work on and the solution of professional tasks are directly related to the relevant professional skills.

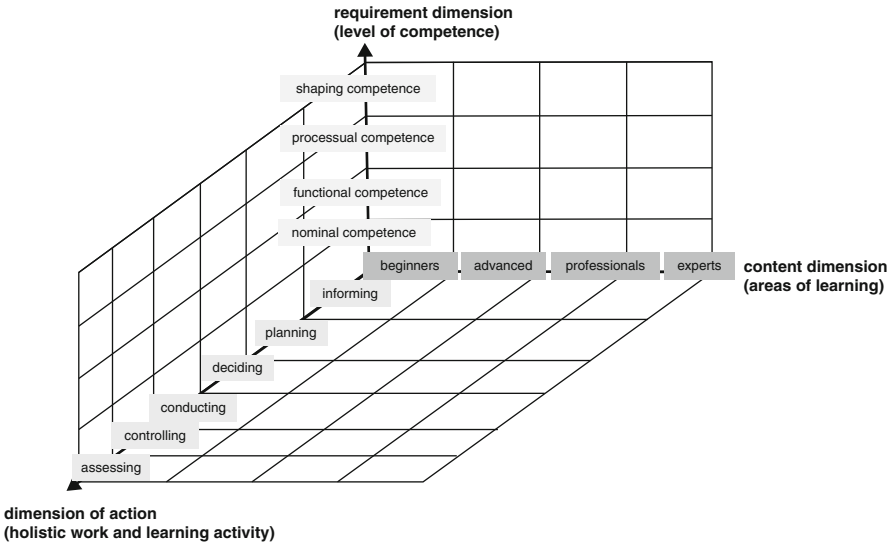

Fig. 3.1 Dimensions of the COMET competence model

The requirement dimension in the COMET model follows the criteria of the holistic solution and thus allows for the concrete description (in terms of content) of empirically tested competences at different levels. It can describe how the solution of tasks looks like when the professional has a high level of competence and how it looks like when the competence level is low. What is of interest here is the *quantitative* and *qualitative* differences between the competence levels as well as the competence profiles that arise from the assessment of the eight competence criteria. The evaluation of the test results allows for a *criteria-oriented interpretation* of the quantitative scores (performance indicators).

The framework for the interpretation is constituted by the eight criteria of the competence model with its three levels (Fig. 3.2). The criteria-oriented interpretation of the quantitative values includes a pragmatic definition of rules as described below, for the transition from one competence level to the next requires the definition of threshold values as well as rules according to which a participant is assigned to a competence level. This feature distinguishes the COMET methodology from norm-oriented test procedures where the boundaries between the competence levels are drawn on the basis of the complexity and degree of difficulty of the test assignments.

A multi-level model implies the idea that the competence levels represent a ranking in the sense of an increasingly higher value of competences. In the case of the COMET model, the first competence level is the lowest and the third one the highest possible level of competence. The levels that can be attained by a trainee are independent of the phases of the training process.

The competence model presented here makes it possible to determine, with the help of open test assignments, the competence level that a solution belongs to. This is independent of the phases of competence *development* in the course of a

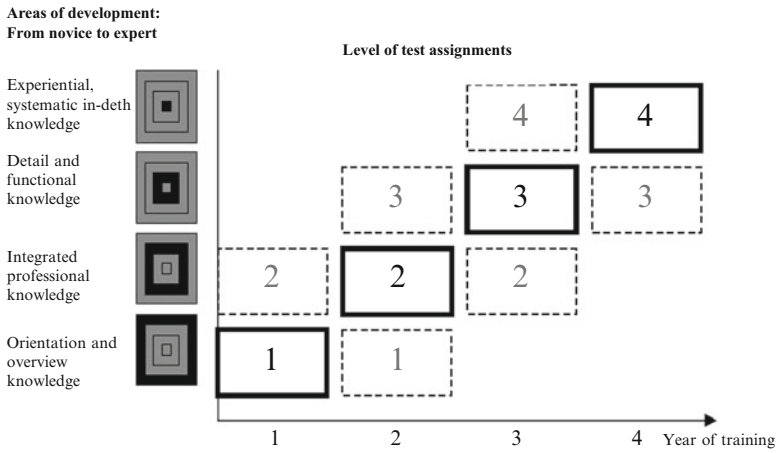

Fig. 3.2 Correspondence of test assignments and learning areas in vocational education and training as basis for a cross-over design

training programme of several years. The cross-over test arrangement also allows to measure the professional competence development during the training process. We refer to this as *competence development levels* according to the novice-expert paradigm.

When one reviews concepts of competence assessment in empirical educational research, one encounters the concept of "literacy". As mentioned before, the PISA project interpreted basic education in the natural sciences as "literacy". Following Bybee's (1997) design for the study of successive literacy levels, it is possible also in VET research to draw a distinction of a total of four competence or literacy levels (see Table 3.1).

The further development of Bybee's concept of scientific literacy was achieved by the Science Expert Group (2001) on the basis of an analysis of the test items. The result was a division of the functional and the conceptual-procedural competence levels into two sub-categories each. It remains to be seen whether this improves the understanding of scientific literacy. The epistemic value of Bybee's concept lies certainly in the fact that a clear distinction is drawn between functional and procedural competence or literacy. From a didactical point of view, there is also an interesting parallel between the competence level of multidimensional literacy (Bybee) and the concept of holistic shaping competence (COMET).

3.3.2 The Content Dimension

The content dimension of a competence model describes the contents of teaching and learning in a specific subject or area of learning as a basis for the development of test assignments. In projects of international comparative competence assessment, it is crucial to identify, following the idea of a "world curriculum" (PISA), contents

Table 3.1 Competence levels in scientific literacy and industrial training

Competence levels	Bybee (1997)	COMET 2008	PISA, scientific literacy
Nominal	I Nominal literacy: some technical terms are known. The understanding of a situation is largely limited to naïve theories. Narrow and superficial knowledge.	I Nominal competence/: superficial conceptual knowledge that does not guide activity, the meaning of the professional terms remains at the level of colloquial language.	I Nominal competence: simple factual knowledge and the ability to draw conclusions without extending beyond everyday knowledge.
Functional	II Functional literacy: scientific vocabulary is used adequately in a narrow area of situations and activities. The terms are hardly reflected and the background remains unknown.	II Functional competence/: basic technical knowledge leads to technical-instrumental skills. "Professionalism" is displayed as decontextualized technical knowledge and corresponding skills ("know that").	II Functional competence I: common scientific knowledge constitutes the ability to evaluate simple situations on the basis of facts and simple rules. III Functional competence II (scientific knowledge): scientific concepts can be used for the prediction or explanation of events.
Conceptual-processual	III Conceptual and processual literacy: concepts, principles and their context are understood, as are basic modes of scientific thinking and working.	III Processual competence/: professional tasks are interpreted in the context of company work processes and situations. Work process knowledge leads to professional action competence ("know how").	IV Conceptual-processual competence I: elaborate scientific concepts can be used for the prediction and explanation of events.
Multidimensional, holistic	IV Multidimensional literacy: at this level an understanding of the essence of science, its history and its role for culture and society is attained.	IV Holistic shaping competence/: the complexity of professional work tasks is fully realized, and tasks are solved with a view to diverging demands and in the form of intelligent compromises.	V Conceptual-processual competence II (models): analyse scientific studies with regard to the design and the hypotheses tested, develop and apply simple conceptual models.

that are characteristic for a discipline or an area of learning. This makes it necessary to abstract from the specific national or local curricula. Accordingly a derivation of the test contents from existing vocational curricula or training plans is ruled out for several reasons.

1. One of the justifications for a comparative large-scale measurement in the field of vocational education lies in the perspective of using the test results for comparing the strengths and weaknesses of existing VET systems and programmes, provided that the specific curricula can be assigned to the same fields of professional activity. Therefore, the COMET project adopted the concept of *professional validity* as a criterion for the definition of the contents of test assignments. The validity has to be demonstrated for the fields of professional activity in question. The World Skills were mentioned as an example. With a striking naturalness the professional communities manage to reach a consensus on occupational profiles and above all on the project tasks for the "professional contests". For the members of the relevant "community of practice" it is plain to see, as it were, what it is that defines real mastery in their profession.
2. Vocational curricula are oriented towards specific forms and systems of vocational education. A comparative competence assessment therefore cannot be based on a specific type of training, e.g., dual vocational education and training. Already the countries that have established systems of dual VET, such as Denmark, Norway, or Switzerland, would be too different from each other. Especially the relation between the definition of overarching (national) standards and their implementation at the local level in the form of training plans is organized in very different ways. Both in Switzerland and in Denmark the responsibility for the implementation of the lean national occupational profiles is with the actors at the local level. The structuring of training programmes in terms of content and time can be based on highly divergent concepts. Apart from an organization according to the subject matter, the structure of the temporal sequence of the contents is largely based on pragmatic considerations. Training concepts that have a scientific basis are an exception.

Therefore, the definition of a validity criterion for the contents of the curriculum and the corresponding test assignments is very important for vocational education and training as one and the same field of activity can be trained in different ways. School-based, company-based, and dual types of training are competing with each other in the national and international context. What is undisputed is the idea that the goal of vocational education and training is professional aptitude. The latter comprises the qualifications that enable a person to exercise an occupation. In colloquial language and policy debates, the terms "qualification" and "competence" are often used interchangeably. In the first chapter, we have explained why it is necessary, in the scientific foundation of assessment and diagnostic procedures, to observe the distinction between these two concepts. To what extent different forms of VET programmes succeed in imparting cognitive performance dispositions at the level of professional aptitude can be investigated by competence diagnostics. The same is true for the measurement of competence development at different steps of the training

process. The evaluation of professional aptitude in the sense of professional *action* competence, on the other hand, is a topic for assessment and examinations.

If the content dimension is described in the form of a model for the systematization of contents that can be applied to vocational education and training, the advantage is as follows. It was mentioned in the previous chapter that the novice-expert paradigm makes it possible to arrange the occupation-specific training contents according to learning areas. Granted that the legitimacy of vocational education and training is based first and foremost on the fact that it supports the integration into a profession – the development from novice to expert – by giving learners the opportunity to develop their professional competence through the solution of professional tasks, the most promising approach to the structuring of the content dimension is a model based on development theory. The organization of work tasks according to the levels of novices, advanced beginners, competent performers, and proficient performers offers a basis across different occupational areas for the systematic identification and selection of contents for the construction of occupation-specific test assignments.

The COMET competence model thus has a content dimension that is justified by learning and development theory. The application of this dimension in the development of test assignments for specific occupations and occupational areas makes it possible to achieve an *occupation-specific implementation of a trans-occupational test concept.* This way the competence levels and competence development of learners in different occupations and different VET systems can be assessed comparatively. At the same time this concept provides the opportunity to systematically evaluate the competence development at different stages of a vocational training process (see Fig. 3.2).

When the content dimension of the competence model is applied and specified, one has to distinguish the phases of competence development (from novice to skilled worker or professional) and the professional competence attained upon completion of the vocational training programme. If the acquisition of qualifications in the course of the incremental development of professional aptitude is organized in accordance with the developmental logic of qualifications and corresponding fields of activity and learning, the result is a structure that serves as the basis for the development of test assignments.

Whenever the competence development is to be assessed over the entire training period, it is necessary to identify the characteristic work tasks and to arrange them as developmental tasks. The situation is easier when the competence level towards the end of the training programme has to be evaluated. In this case, the point of reference is the professional aptitude as described in the relevant occupational profiles. In international comparative studies, it does not make sense to refer to the more formalized descriptions in the form of standards or training regulations, for this would lead to an overrating of the formal aspects and impede the development of test assignments. The experience of the international COMET study (German and Chinese students in the area of electrical engineering and electronics) shows that the selection of appropriate (characteristic) work tasks is possible without much difficulty. The implicit validity criterion applied by the educators involved consists, besides their common vocational discipline, in the professional work in the area of

electrical engineering and electronics. The communication about the contents of competence development takes place at the level of professional fields of activity, on the one hand, and through the selection and development of test assignments, on the other hand.

3.3.3 The Criteria of Holistic Problem Solving as Competence Criteria

The theoretical definition of the competence levels on the basis of the eight criteria for the holistic solution of tasks is based on the following considerations.

The *functionality* of a solution and its clear presentation must be given before the relevance of the other criteria comes into play. When the aspects of economy, utility, and sustainability as well as business and work process orientation are considered in the solution of test assignments, then the candidates have a *professional concept of work* (as opposed to an academic and merely *functional* understanding of the tasks).

The solutions that can be classified under this competence level demonstrate that the competences that are essential from an occupational as well as organizational point of view.

The third competence level is defined by skills that reach beyond business and work processes and aim at aspects of *social* relevance. This means that there is a hierarchical order of competence components and solution aspects in the sense that an increase in competence is associated with a wider perspective of the trainees of the issues to be considered in problem solving. A purely technical or functional competence is followed by organizational and social problem solving competences at the higher levels.

Nominal competence has to be excluded from the field of *professional* competences when competence development is defined, as in the case of the COMET model, as a characteristic criterion for the success of a vocational training programme. Trainees who attain only the level of nominal competence are regarded as a risk group. When one looks at the definition of the first competence level (functional competence), it becomes clear that trainees who do not reach this level are likely to fail in the training programme. Their actual competence level is equivalent to the level of unskilled or semi-skilled work. It remains to be investigated as to whether and in what time they can develop into skilled workers on the job (Fig. 3.3).

- Functionality/operability: The functionality of a proposed solution is an evaluation criterion that immediately presents itself. Functionality refers to the instrumental technical competence or the context-independent, subject-specific knowledge and skills. Evidence of the functionality of a solution is fundamental and determines all further requirements that are posed for the solution of work tasks.
- Clarity/presentation: The results of professional tasks are anticipated in the process of planning and preparation, and they are documented and presented in such a way that principals (customers, work superiors) can understand and review the

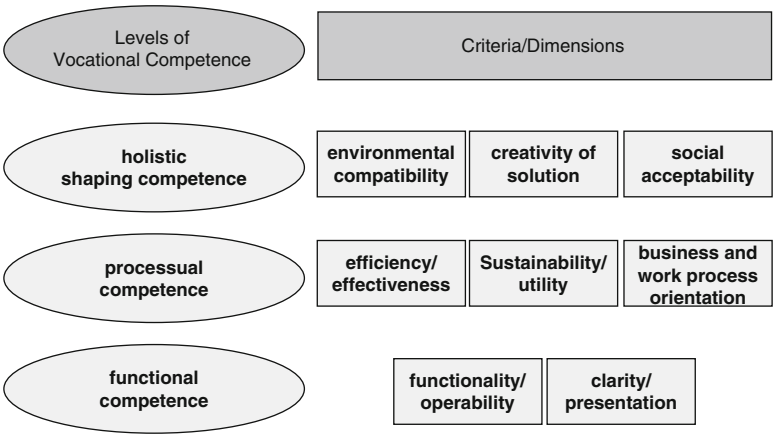

Fig. 3.3 Levels and criteria of professional competence (Rauner et al. 2007, 23)

proposed solutions. Accordingly the explanation and presentation of a solution is an instance of professional learning and professional work. A core element of communication in the work context is the ability to express one's thoughts in a clear and organized way by giving accounts, drawings, and sketches. The adequacy of the presentation with regard to the facts is a sign of professionalism.

– Efficiency/effectiveness: Professional work is in principle subject to the aspect of economy. The context-specific consideration of economic aspects in the solution of professional tasks is a characteristic of the competent activity of professionals. There is a constant necessity in professional work to evaluate how economically a task is carried out, and to consider quite diverse types of costs and influences. Costs that will be incurred in the long run (derivative costs) need to be taken into account as well. Decisions are made on a summative assessment of the ratio of expenses and benefits. In addition, economic responsibility also includes an awareness of the societal aspects as not all strategies that make sense at the organizational level may also be acceptable for the national economy.
– Sustainability/utility: Professional activities, workflow, work processes, and work assignments are ultimately oriented towards a customer, whose concern is the utility of the work result. In highly diversified production and service processes, the aspect of utility often gets out of sight when subtasks are performed and vocational education is reduced to the aspect of action. The criterion of utility orientation therefore points at the utility of a solution in the entire context of work. A high utility of a solution depends not only on its immediate applicability for the customer but also on the prevention of liability to failure and the consideration of aspects of easy maintenance and repair. Sustainability of application and the perspectives for enhancement must also be taken into account when the utility is assessed.
– Business and work process orientation: This criterion refers to the preceding and the following operations in the organizational hierarchy (the hierarchical

aspect of the business process) and in the process chain (the horizontal aspect). This aspect is particularly relevant in an environment characterized by programmed work systems in networks in and between companies. A business process oriented solution takes into account the linkages with the preceding and following processes and includes also the aspect of cooperation beyond the boundaries of one's own professional work.

- Environmental compatibility: By now this criterion has become relevant for almost all work processes. What is at stake here is not the aspect of environmentalism in general, but the professional and technical requirements for professional work processes and their results that can be considered relevant for the criteria of environmental compatibility. It has to be taken into consideration whether environmentally friendly materials are used and whether an eco-friendly work organization is followed in the solution of the work task. Other issues that need to be considered are energy-saving strategies and aspects of recycling.
- Creativity: The creativity of a solution is an indicator that plays an important part in professional problem solving. This is due to the fact that the room for maneuver for the solution of professional tasks varies strongly in the different work situations. The criterion of a "creative solution" has to be interpreted and operationalized in an occupation-specific way. In the arts and crafts, creativity is a core aspect of professional competence. In other domains, the aspect of "creative solution" is a relatively independent concept of professional work and learning. The distinction of creativity in a specific solution also shows the sensitivity for the problems to be solved. Competent professionals are expected to find creative and unusual solutions which at the same time make a meaningful contribution to the attainment of the goal.
- Social acceptability: This criterion refers above all to the aspect of a humane organization of work, health protection as well as the social aspects of professional work that go beyond the work context (e.g., the often divergent interests of principals, customers, and society). This includes aspects of work safety and prevention of accidents as well as the potential impact of a specific solution on the social environment.

3.3.4 The Action Dimension

Alongside the pedagogical differentiation of the categories of vocational education and professional competence, the paradigm of "complete professional action" gained support and acceptance in theory and research in labor studies, which aimed at a humanization of the world of work. The manifold efforts in labor studies to develop a scientific foundation of this concept obscure the fact that the category of complete professional action ultimately has a normative basis. The concept is rooted in the critical reflection of the Taylorist organization of work and the interest to counteract the dequalification in fragmented work processes with a shaping concept

based on labor studies. Empirically the concept of complete professional action is supported by many HdA (*Humanisierung des Arbeitslebens*, humanisation of the world of work) and "Arbeit und Technik" (work and technology) projects, which demonstrated that non-Taylorist types of work organization were an advantage under the conditions of international competition (Ganguin 1992).

Referring to Hellpach (1922, 27), Tomaszewski (1981), Hacker (1986), and Volpert (1987), Ulich emphasizes five characteristics of "complete" or "holistic tasks":

1. The independent definition of objectives that can be embedded into overarching goals
2. Independent preparatory activities in the sense of exercising planning functions
3. Selection of instruments including the relevant interaction for adequate goal attainment
4. Executive functions with process feedback for a continuous opportunity to correct activities
5. Review and feedback on outcomes with the opportunity to evaluate the matching of results of one's activities with the defined objectives (Ulich 1994, 168)

What is remarkable here is that Ulich emphasizes the category of "holistic tasks", thereby referring to the shaping of work as a core research topic in labor studies. When the action dimension is adopted in the COMET project, we follow this tradition of labor studies where the design of work tasks is always viewed also as an aspect of personality development. This is one of the roots of the programmatic relevance that the idea of holistic tasks has gained in vocational pedagogy. Another one is the degree of medium-level operationalization in the form of the differentiation of the complete work and learning action in successive steps of activity. This scheme provides some degree of orientation and security for the didactic activities of teachers and trainers. Moreover, this structural model of agency was disseminated also at the international level through the introduction of the concept of learning areas in curriculum development.

The supplementation of the COMET competence model with the action dimension and the diversification of the latter into six steps of activity took place with a view to justifying the concept of holistic problem solving. This concept is constituted by the requirement and action dimensions. This way the competence model as basis for the development of test assignment and the rating of the solutions are further refined.

A reservation must be made with regard to the description of the action dimension because the steps of the complete professional activity suggest an approach of instrumental rationality in didactics that is appropriate for the situation of beginners and less so for advanced learners and experts (see above all Dreyfus and Dreyfus 1988). In the debates in vocational pedagogy, a distinction is drawn between an instrumental-rational type of activity, on the one hand, and a design-oriented and dialogical type, on the other hand (Brater 1984). The two types of activity are essential for each occupation, but their relative importance varies. Professional tasks with a clearly defined objective, e.g., the specification of a solution for a technical problem, require a structured and systematic approach. The objective determines how one proceeds in

problem solving. The concept of holistic work activity has a clear affinity to this instrumental type. This type is prevalent in specified work processes and projects where the room for maneuver is relatively small. If the opportunity for design exists at the stage when the work assignment is formulated, this opportunity is diminished or removed already in the phase of work preparation by exactly defined work steps.

The design-oriented and dialogical type of activity is characterized by an openness of objectives and by a course of activities that can be foreseen and planned only to a limited extent. The sequence of work steps emerges no sooner than in the work process itself. For instance, educational processes are largely open. Schoolteachers and kindergarten teachers respond to the impulses, suggestions, questions, and answers of the children/pupils. This means that the learners, being the subjects of the learning process, co-determine the course of the educational process. To some extent the teacher anticipates, in the preparation of a lesson, the potential reactions of the pupils. He simulates the lesson in his mind, considering the possible ramifications. The actual course of events, however, can be anticipated only to a limited extent. The situation is similar with regard to activities in diagnostic work processes, e.g., in industrial and technical occupations where error diagnosis plays an important part. A particular relevance of the design-oriented and dialogical type of activity can be found in artistic professions. A painter is guided by a specific idea in the painting of a picture, but the way the picture ultimately takes shape is the outcome of a constant dialogue between the artist and his work of art.

In the practice of professional work, the two types of activity overlap. When the design-oriented and dialogical type dominates, it is reasonable to use open test assignments in the form of situation descriptions in such a way that the time frame can be overlooked by the test persons and the opportunities for action as well as the ramifications can still be described. These conditions need to be taken into consideration in the development of test assignments. Two assignments are appropriate for the comprehension and solution of a technical problem when the instrumental-rational aspect is dominating. The anticipation of a teaching situation in the context of a test with a working time of approximately 120 min for each assignment, on the other hand, seems rather unrealistic because normally the pedagogical activity of teachers can be anticipated only for shorter time cycles. Here a comparison with a chess player can be drawn. The planning of possible moves depends on the anticipation of the opponent's behavior. More than four or five moves cannot be estimated in advance because the number of potential courses of the game grows exponentially (which is why the actual behavior of chess players is based above all on the knowledge of typical patterns). Therefore, our recommendation is to raise the number of open test assignments in occupations with a distinct design-oriented and dialogical profile to four. The working time is then reduced to a maximum of 60 min per assignment. The opportunity to analyse and reflect complex processes should be retained because this is a sign of professionalism and competence in occupations with a high degree of design-oriented and dialogical activities. At the same time this test method reaches its limits when the time frame for the work situations is overstretched. Therefore, the following rule has to be observed: the alternative courses of action associated with the test assignments must be easy to oversee.

It will be possible only on the basis of empirical investigations to formulate this rule more precisely. This includes studies on the limitations of a standardized competence diagnostics that are constituted by the contents of professional work.

3.4 Measuring Commitment, Professional Identity, and Context Data

For the COMET project, commitment (see Sect. 2.4) is not in the first place relevant as a predictor of work performance, which is the predominant view in the research literature (cf. Blau and Boal 1989; Hafer and Martin 2006; Kacmar et al. 1999; Naquin and Holton 2002; Weller et al. 2005). This would be difficult already because commitment is conceptualized as a disposition of employees in favor of their job and/or their company that has consolidated over time and that is strong enough for reliable tests only after some years. In addition, the construct of organizational commitment usually includes the tendency to continue employment with the enterprise. These two facts make it difficult to apply the commitment approach to trainees when commitment is to be interpreted as a reliable predictor of work performance. Instead, commitment is relevant in connection with the development of professional identity when the assessment of professional competence is at stake. The *normative areas* to which commitment refers are decisive. Occupational commitment is defined as orientation towards the job and is distinguished from organizational commitment as orientation towards the enterprise and work ethic as the general motivation to work. Professional identity, on the other hand, denotes a combination of attitudes corresponding to the development from novice to skilled worker in the course of the training process, e.g., quality awareness or self-initiative. These scales offer a sufficiently selective instrument for the monitoring of competence acquisition during a vocational training programme, provided that they are related not only to the professional competence of trainees, but also to the organization of the training process in the company and the vocational school.

The COMET project investigates organizational and occupational commitment with the help of established scales (Mowday et al. 1979, 1982; Meyer and Allen 1991; Meyer et al. 1993; Balfour and Wechsler 1996) that were modified so as to be applicable to the attitudes of trainees. For the measurement of professional identity, a new scale was theoretically derived. Finally, the course of the training process at the learning venues enterprise and school is surveyed with the "Mannheim Inventory for the Analysis of In-Company Training Situations" (*Mannheimer Inventar zur Erfassung betrieblicher Ausbildungssituationen* – MIZEBA; cf. Zimmermann et al. 1999), which has also been modified for this purpose, and with the help of adapted questionnaires for the school-based part of the training. MIZEBA breaks down the training situations in the company according to characteristics of learning tasks (complexity of assignments, variety, matching of demands and skills levels, autonomy, relevance of tasks), characteristics of the learning arrangement in the company (measures to support transparency, inclusion into the expert culture of the company), and characteristics of the learning environment (work climate, social inclusion).

With regard to the vocational school, scales developed by the German Institute for International Pedagogical Research (DIPF) were used. The scales and other survey instruments were tested in two pretests for their reliability and practical applicability in the COMET project.

As shown above, the assessment of professional competence has to be developed out of the process of professional work and in consideration of the educational objective of professional action competence. Therefore, it is necessary to include the relevant subjective dispositions and motivations. The toolkit presented here makes it possible to identify the essential processes in the development of professional competence and their respective fields of reference in the course of the training programme, and to associate them with the corresponding levels and dimensions of professional competence. The analysis of work-based and school-based training situations also allows for the identification of important factors of the development of professional competence and identity, which delivers not only data for competence diagnostics, but also data for the direct evaluation of the training quality.

References

Balfour, D. L., & Wechsler, B. (1996). Organizational commitment. Antecedents and outcomes in public organizations. *Public Productivity and Management Review, 29*, 256–277.

Baumert, J., Klieme, E., Neubrand, M., Prenzel, M., Schiefele, U., Schneider, W., Stanat, P., Tillmann, K.-J., & Weiß, M. (2001). *PISA 2000: Basiskompetenzen von Schülerinnen und Schülern im internationalen Vergleich*. Opladen: Leske + Budrich.

Blau, G., & Boal, K. (1989). Using job involvement and organizational commitment interactively to predict turnover. *Journal of Management, 15*, 115–127.

Brater, M. (1984). Künstlerische Übungen in der Berufsausbildung. In Projektgruppe Handlungslernen (Hrsg.), *Handlungslernen in der beruflichen Bildung* (pp. 62–86). Wetzlar: W.-von Siemens-Schule, Projekt Druck.

Bybee, R. W. (1997). *Achieving scientific literacy: From purposes to practices*. Portsmouth: Heinemann.

Dreyfus, H. L., & Dreyfus, S. E. (1988). *Mind over machine: The power of human intuition and expertise in the era of the computer*. New York: The Free Press.

Ganguin, D. (1992). Die Struktur offener Fertigungssysteme in der Fertigung und ihre Voraussetzungen. In G. Dybowski, P. Haase, & F. Rauner (Hg.), *Berufliche Bildung und betriebliche Organisationsentwicklung*. Bremen: Donat Verlag.

Gardner, H. (2002). *Intelligenzen. Die Vielfalt des menschlichen Geistes*. Stuttgart: Klett-Cotta.

Hacker, W. (1986). *Arbeitspsychologie. Psychische Regulation von Arbeitstätigkeiten*. Bern: Huber.

Hafer, J. C., & Martin, T. N. (2006). Job involvement or affective commitment: A sensitivity analysis study of apathetic employee mobility. *Journal of Behavioral and Applied Management, 8*(1), 2–19.

Hellpach, W. (1922). Sozialpsychologische Analyse des betriebswirtschaftlichen Tatbestandes ‚Gruppenfabrikation'. In R. Lang & W. Hellpach (Hrsg.), *Gruppenfabrikation* (pp. 5–186). Berlin: Springer.

Kacmar, K. M., Carlson, D. S., & Brymer, R. A. (1999). Antecedents and consequences of organizational commitment: A comparison of two scales. *Educational and Psychological Measurement, 59*, 976–994.

Klieme, E., & Leutner, D. (2006). Kompetenzmodelle zur Erfassung individueller Kernergebnisse und zur Bilanzierung von Bildungsprozessen. Beschreibung eines neu eingerichteten Schwerpunktprogramms der DFG. *Zeitschrift für Pädagogik, 52*(6), 876–903.

Meyer, P. J., & Allen, N. J. (1991). A three-component conceptualization of organizational commitment. *Human Resource Management Review, 1*, 61–89.

Meyer, P., Allen, N. J., & Smith, C. A. (1993). Commitment to organizations and occupations: Extension and test of a three-component conceptualization. *Journal of Applied Psychology, 78*, 538–551.

Mowday, R., Steers, R., & Porter, L. (1979). The measurement of organizational commitment. *Journal of Vocational Behavior, 14*, 224–247.

Mowday, R., Porter, L., & Steers, R. (1982). *Organizational linkages: The psychology of commitment, absenteeism and turnover*. New York: Academic.

Naquin, S. S., & Holton, E. F. (2002). The effects of personality, affectivity, and work commitment on motivation to improve work through learning. *Human Resource Development Quarterly, 13*(4), 357–376.

Rauner, F., Grollmann, P., & Martens, T. (2007). Messen beruflicher Kompetenz(entwicklung) (ITB – Forschungsbericht, 21/2007). Institut Technik und Bildung (ITB), Bremen.

Rost, J., Walter, O., Carstensen, C., Senkbeil, M., & Prenzel, M. (2005). Der nationale Naturwissenschaftstest 2003. *Mathematischer und Naturwissenschaftlicher Unterricht, 58*(4), 196–203.

Schecker, H., & Parchmann, I. (2006). Modellierung naturwissenschaftlicher Kompetenz. *Zeitschrift für Didaktik der Naturwissenschaften (ZfDN), 12*, 45–66.

Science Expert Group. (2001). *Record of meeting in Brussels*. Paris: OECD.

Tomaszewski, T. (1981). Struktur, Funktion und Steuerungsmechanismus menschlicher Tätigkeit. In T. Tomaszewski (Hrsg.), *Zur Psychologie der Tätigkeit* (pp. 11–33). Berlin: Deutscher Verlag der Wissenschaft.

Ulich, E. (1994). *Arbeitspsychologie* (3rd ed.). Stuttgart: Schäffer-Poeschel.

Volpert, W. (1987). Psychische Regulation von Arbeitstätigkeiten. In: U. Kleinbeck & J. Rutenfranz (Hrsg.), Enzyklopädie der Psychologie, Themenbereich D (Vol. 1, pp. 1–42). Göttingen: Hogrefe.

Weller, I., Matiaske, W., & Holtmann, D. (2005). Leistungsorientierung, Ressourcen und Nachhaltigkeit in öffentlichen Betrieben: Zur „Machbarkeit“ von Extra-Rollenverhalten und Commitment. In M. Moldaschl (Hg.), *Immaterielle Ressourcen: Nachhaltigkeit von Unternehmensführung und Arbeit* (Vol. 1, pp. 131–142). München/Mering: Hampp.

Zimmermann, M., Wild, K.-P., & Müller, W. (1999). Das „Mannheimer Inventar zur Erfassung betrieblicher Ausbildungssituationen“(MIZEBA). *Zeitschrift für Berufs- und Wirtschaftspädagogik, 95*, 373–402.

Chapter 4
Test Development and Design of the Study

4.1 Development and Selection of the Test Tasks

4.1.1 Development of Test Tasks

The test tasks are the core of the surveys in the COMET project; they are the result of the technical, didactical, and psychometrical preparation of the large-scale measurement. In order to guarantee the objectivity of the test, measures were taken to make sure that none of the test tasks would become known in advance. For instance, all people involved in the COMET project committed themselves to treat the assignments confidentially.

The test tasks were formulated with reference to the four levels of competence that build on top of one another and to the professional development tasks identified by means of expert worker workshops. These open assignments allow for a large scope of possible solutions.

The test tasks confront the candidates with professional tasks that are characteristic for their occupations. In the COMET project, the trainees at the end of their training programme and in the second year of training are tested by means of test tasks that are targeted at a decent professional aptitude. The test tasks are formulated in such a way that they can also be mastered by second-year trainees. The understanding is that the solutions clearly reveal the differences in the competence development between the second and the third year of training. The guidelines according to which the test assignments are developed are depicted in Table 4.1.

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Table 4.1 Guidelines for the development of test tasks

The test tasks
Cover a realistic problem of the professional and corporate work practice.
Incorporate the characteristic professional work tasks of the occupation and the corresponding training objectives, organized into tasks for novice, advanced beginner, competent performer and proficient performer.
Constitute an occupation-specific and relatively broad room for maneuver and allow for a multitude of different solution variants with different scope and depth.
Are open for design, i.e., there is not one "right" or "wrong" solution, but there are application-oriented variants.
Require not only technical competences, but also the consideration of aspects like efficiency, utility, and environmental compatibility.
Require an approach that is typical for the profession. The mastering of the task focuses on the aspects of planning and conception and is documented by appropriate forms of expression (paper and pencil design).
Need not be solved practically because the test assignment assesses professional competence development at the conceptual level and not at the level of concrete proficiency (performance).
Are not an assessment of learning achievements; the assignments do not refer to school curricula or syllabi.
Challenge the candidate to master the task in the sense of professionalism (at the respective developmental level), to document the solution and to justify it. Reduced solutions are not excluded.

The development of test tasks for the different moments within the training programme is based on the development tasks that are assigned to the four areas of development. Table 4.2 shows a juxtaposition of the areas of development 1 (knowledge for orientation and overview) and 4 (knowledge guided by experience and systematic in-depth knowledge) from the training plan for tool mechanics.

In the formulations of the test tasks, explicit aids and hints were avoided. The briefly formulated tasks represented work assignments in which the solution paths were determined only by the relevant performance requirements, without giving any privilege to specific solutions.

A test tasks is supplemented by a description of the situation. The latter is describing the context into which the assignment is embedded. The description is realistic and is illustrated by images (e.g., photos, charts) that give additional information about the context.

The test tasks and situational descriptions do not include detailed specifications. They are formulated with a view to utility.

The solution of the test tasks is not limited to the description of the proposed solution, but includes also a detailed justification of the proposal. This means not only a presentation of the concept, e.g., by sketches, descriptions, and lists of items, but also a justification of the proposal to be presented to a customer.

The requirement of comprehensive and detailed justifications for a solution makes clear that this is not a real work assignment in a company, but a test. In practice, a skilled worker will not always be required to justify the way a task is fulfilled. The principal or customer will be informed only upon request what reasons were decisive for the choice of a particular solution. In the daily work routine, the results

Table 4.2 Juxtaposition of the areas of developments 1 and 4 from the training plan for tool mechanics

Area 1	Area 4
Knowledge for orientation and overview	Knowledge guided by experience and systematic in-depth knowledge
Characteristic work tasks	Characteristic work tasks
1. Production of components	1. Error analysis in tools and appliances
2. Production and quality control of network components	2. Construction and modification of tools/appliances and realization of the former
3. Assembly/disassembly of tools and appliances	3. Initial operation and adaptation of tools and appliances
4. Maintenance of tools and appliances	4. Optimization of tools and appliances
Type of assignment and activity	*Type of assignment and activity*
In the first area the toolmaking trainee approaches the subject of the occupation (tools) via the outputs of industrial mass production that are created with tools. The perspective is focusing not so much on single components of tools or metalwork procedures, but on the real production process with the help of tools. The view of the function of toolmaking as a basis for the following production process gives the trainee an orientation about the future application of the tools created by his professional group.	*The assignments of the fourth area are characterized by a particular complexity and lack of transparency. For instance, error analyses are necessary when the items produced with the help of tools no longer meet the quality standards or when damages of the tool or appliance occur during the production process. The error analysis is the basis for the commencement of repair activities, the proposal of modifications in the construction or the optimization of the production process. If errors and disturbances occur repeatedly, tools/appliances have to be newly constructed or modified. This requires innovative solutions, which often cannot build upon patterns or models already available. Accordingly they open up particular design opportunities.*
An overview of the production with tools is acquired during the maintenance of tools in combination with the production and quality control of items.	

Source: Rauner and Haasler (2001), 6 ff

will often be self-explaining. The evaluation of tests, however, is facilitated and the interrater reliability is brought to acceptable values when the solutions of the open assignments are subject to explicit justification.

4.1.2 Pretest

In a multiphase process, 12 test tasks were developed, which were to serve as the basis for the main survey. The development team decided to test all assignments in order to have as many options as possible for the selection of the four tasks needed for the main survey. The complex procedure was made up of the following steps.

1. *Collection of existing assignments from contexts of instruction and examination:* Building upon the framework concept of the COMET project the development team started to collect already available assignments from the teaching and assessment practice of the teachers. It became clear very soon that learning achievement tests and exams have different objectives so that their structure is little appropriate for the COMET project. However, some features of available assignments were quite inspiring for the further work. These core elements of assignments were collected for a possible future development of evaluation tasks.
2. *Systematic collection of ideas for new test assignments:* Based on the framework for the assessment of professional competence (see Chap. 2), ideas for new test assignments were collected systematically. These were inspired particularly by the work assignments of electronics technicians, which were used by teachers to derive test assignments. The collection of ideas took place in several working sessions of the test development team, which was composed of 12 teachers and the scientific monitoring group.
3. *Development of test assignments in working groups of the development team:* Working groups with three teachers in each group were set up to specify the test assignments on the basis of the fundamental ideas generated by the entire development team.
4. *Preselection of the assignments for the two electronics technician occupations (industry and crafts):* The COMET research design follows the approach to evaluate trainees for the occupation of electronics technician in the industry as well as in the crafts sector. Given that the two occupational profiles overlap to a vast extent, but have quite independent tasks and fields of application in the professional practice of the skilled workers, it was necessary to develop test assignments that match both profiles. In a discursive process, the development team as a whole was presented the newly developed test assignments, which were then scrutinized as to whether and to what extent they were capable of representing both occupational profiles.
5. *Evaluation of the applicability at both test dates:* The survey design foresees a cross-over arrangement of the test assignments, which are used at both survey dates (see below). Each test assignment therefore has to be challenging for

participants at different moments of their professional competence development in the training process and be regarded as a serious task.

6. *Pretest of the assignments and analysis of the results:* The twelve evaluation tasks prepared by the test development team were pretested in the field. Even though only four test assignments were needed for the main survey, the team decided to test as many assignments as possible in order to be able to make an informed choice for the main survey.
7. *Selection of four test assignments for the main survey:* The cross-over design of the study required the selection of sets composed of two test assignments. Following the pretest, which had already provided experience with such sets, the grouping of specific test assignments into sets was once more discussed in depth for the main survey.
8. *Revision of the four test assignments on the basis of the insights delivered by the pretest:* Finally the four test assignments selected for the main survey were put under editorial review and revision. The task assignment and the situational description were formulated more precisely. With regard to the descriptions of situations, particular emphasis was given to illustrations that made clear that the test assignments were rooted in real professional work tasks.

Out of the six vocational schools participating in the project, three were selected for the pretest. In order to have each assignment worked upon by approximately ten candidates so that a significant sample could be guaranteed, a total of 93 trainees from each of the two occupations (industry and crafts) and the two cohorts (second and third year of training) were selected. The response rate was 79% of the sample.

The number of participants in the pretest was kept low in order to avoid any confrontation of the test persons with the assignments prior to the main survey to the fullest possible extent and to limit rehearsal effects.

The main objectives of the pretest were

- To gain experience with the practical application of the instrument
- To collect information for the selection of test assignments for the main survey
- To check whether the eight evaluation criteria for the assessment of professional competence are represented in the assignments
- To prepare the compilation of sets of assignment for the main survey and
- To collect empirical data for the test ratings and the training of raters

The decision to have two test assignments per test may look unusual at first sight because in competence assessment a larger number of assignments is often viewed as a necessary condition: “Competences can be assessed only on the basis of a range of single observations at different tasks or in various situations” (Klieme and Hartig 2007, 24). However, the development of tasks for the evaluation of professional competence differs from competence assessment in subjects like reading or mathematics.

Especially the following criteria have to be taken into consideration in the construction of tests:

1. Professional (action) competence is demonstrated in the work on professional work tasks. These are embedded in a context of application. Experience shows that

Table 4.3 Representation of the eight criteria in two assignments of a test set

Criterion	Task A1	Task A2
Clearness/presentation	l	l
Functionality	l	l
Utility	l	l
Economy	l	¡
Business and work process orientation	¡	l
Social compatibility	l	¡
Environmental compatibility	¡	l
Creativity	l	¡

l = fully represented; ¡ = partly represented

an occupation can be described on the basis of approximately 12–20 characteristic professional work tasks. When these work tasks are analyzed into sub-tasks, the meaningful context of professional work is disintegrated. The resulting abstract knowledge and skills do not constitute professional (action) competence. The understanding of the context is regarded as a core dimension of professional competence (cf. Laur-Ernst et al. 1992), and this understanding can be assessed only with the help of sufficiently complex tasks. Therefore, it makes perfect sense when the characteristic professional work tasks that constitute the backbone of an occupation are taken as the point of reference for the development of test assignments. As each of the four areas of development includes 3–4 work tasks, two complex test assignments are enough to measure the competence development at the respective level. Two complex test assignments represent no less than 50% of the contents of learning and work incorporated in the characteristic work tasks.

2. The working time for the solution of two test tasks is approximately 4 h since the participants are required not only to work out a solution, but also to give a clear explanation of their proposal. In this time frame, a test assignment represents a wide range of single tasks that have to be mastered in the context of the complex assignment. Accordingly the test concept at any rate covers the scope of professional knowledge.
3. A standardization of the test tasks is possible also in the case of open assignments. The crucial point is the rating procedure. In the course of the test development, it could be confirmed by the pretest that it is possible to cover all of the eight criteria of the competence model with two or even one complex test assignments. Table 4.3 shows the eight criteria that form the basis for the assignments and the solution spaces as they were evaluated by the test developers for two of the pretest assignments.

If it can be confirmed that a sufficient degree of inter-rater reliability can be achieved, then there is good reason to make few and complex test assignments the basis of the assessment of professional competence.

On the whole the pretest led to the following insights, which were taken into consideration in the preparation of the main survey:

– The distribution of both tasks in the set at the beginning of the test turned out to be problematic for the quality of results. Having a “choice” encouraged many of

the participants to concentrate on one of the tasks and leave out the other. For the main survey the design was changed so that the tasks were distributed separately and 2 h of working time were appropriated to each of the tasks.
– The working time of 4 h for two tasks was not fully exploited by many participants, even though a thoroughgoing work on the tasks requires this amount of time. During the test a decline in motivation and signs of fatigue were observed in the participants. This was attributed above all to the test setting, which was quite unfamiliar for the trainees. Many vocational students are not used to work over several hours on complex professional tasks in a school-based and entirely "theoretical" setting. In the face of these observations, it was discussed whether the time frame could be reduced by "lean" assignments or whether a longer break should be provided for instead. The reduction of the working time was rejected for being inconsistent with the core idea of using open assignments that give participants a decent room for maneuver. After all the aim of the assessment procedure is to evaluate the competence development of participants and not their ability to work under time pressure. Accordingly a break of 30 min was placed between the two assignments.
– The formulations of some of the test assignments required revision as revealed by the requests for clarification from many of the trainees.

The eight test assignments that were pretested but not selected for the main survey are used for teaching projects. This way a learning method is supported that is focusing more than others on the acquisition of action competence as defined in the concept of learning areas (see Chap. 9).

4.1.3 Selection of Test Tasks for the Main Survey

Four test assignments were selected for the main survey and combined in sets of two assignments each. The selection was based on the following criteria:

– Confirmation of the "suitability" of the assignment by the pretest (e.g., workability for second- and third-year trainees, possibility to solve the task in 2 h)
– Applicability of the assignment for the industrial occupation as well as for the craft trade foreseen by the design of the study

Two sets of assignments were selected on this basis. One set of assignments includes two main types of tasks that are derived from real work assignments: a *pre-structured work assignment* and a *conceptional planning assignment*.

The characteristic of the pre-structured work assignments is that they require modifications of existing equipment or that specific problems of control engineering have to be solved. Their solution variants are determined by "narrower" situational descriptions. In the real work process, these assignments would be planned by master craftsmen or foremen and commissioned to the skilled worker for execution.

The characteristic of the conceptional planning assignments is that they include fundamental new concepts for the control or energy supply of machines or buildings.

In reality, the impulses for this type of assignment would be determined, e.g., by complex specifications by customers. Here the focus is on the development of innovative and reasonable concepts that can be proposed to the customer for the solution of the problem at hand.

The two types of assignment do not belong to different levels of difficulty. They are both representing the broad scope of tasks in the professional work of electronics technicians.

4.2 Development of the Questionnaire for the Context Data

One of the core objectives of large-scale studies like COMET is not only to record the state or the process of competence development, but also to make a contribution to the identification of the relationship between the context of vocational education processes and the course of these processes. A project like this can only fulfill its evaluative mission if various parameters are investigated with regard to their effects on professional competence development. The insights into the effects of these parameters can then help to draw conclusions for VET practice and education policy.

The two learning venues, i.e., school and enterprise, define the contextual environment for vocational education and training processes. Besides these two entities there are several factors that are brought into the process by the learner, for instance biographical features, attitudes of the learners, peer groups, etc. In order to support the interpretation of the competence development processes monitored by the tests, context data of vocational learning are surveyed as independent variables. These include

- Personal characteristics of the learners
- Characteristics of the enterprise and the in-company training process
- Characteristics of the vocational schools

4.2.1 Personal Characteristics

The first objective is to collect those data about the learners themselves that are relevant for professional competence development (Table 4.4). These include predominantly the educational attainments before the beginning of the training programme and biographical data like socio-economic background, data about possible previously completed or discontinued vocational education, information about prevocational education and preparatory measures, and finally the question of motivation for training.

The *direct* investigation of prior knowledge and general cognitive abilities does not make sense at the present stage of the development of the methodology, given the considerable workload to be expected for such tests. Final marks at important

Table 4.4 Personal characteristics of learners (examples)

Personal background	Educational attainments and previous learning pathway	Motivation for training
Language spoken at home	School qualification	Target occupation
Support from parents	Prevocational education	Relative importance of the occupation in comparison to the training company
Educational background of parents	Final marks in German, mathematics and English	Additional information about vocational orientation
Living area		
General cognitive abilities		

school subjects work as an indirect measure of prior general knowledge. As a stand-in for general cognitive abilities, one non-verbal subtest of the Cognitive Ability Test (CAT 12) was used (see Chap. 5).

The question of the motivation to choose a particular training occupation is the starting point for analyzing the development of professional identity and its connection with competence development. The attitudes to the occupation and to the training enterprise are presumably important predictors with regard to competence and identity.

4.2.2 Characteristics of In-Company Training

Four types of instruments can be identified that are commonly used in the investigation of context data of learning in the company:

- Instruments that focus on the objective conditions of the quality of in-company training in the course of dual vocational education and training
- Instruments and items rooted in (work) psychology that were developed with a view to the problem of the "general" educational content of work processes (Butler et al. 2004; Skule and Reichborn 2002)
- A group of instruments that can be labeled "industry-oriented" and which are used in the corporate quality management of training processes or in the accreditation of training companies and programmes (National Automotive Technicians Education 1996; Ripper et al. 1999)
- Instruments from learning and teaching research on business training, e.g., MIZEBA (Zimmermann et al. 1999).

Apart from their provenance and their objectives, these instruments differ also with regard to the measurement of subjective attitudes of the learners on the one hand and objective indicators on the other. It has to be assumed that general characteristics of the training enterprise already have an impact on the organization of the training process. For instance, experience shows that the variety of the everyday

Table 4.5 Context variables of in-company training

General characteristics of the enterprise	Work process orientation of the training programme	Training situation in the enterprise
Number of employees	Learning venues (training workshop, corporate work process)	Work climate
Number of trainees	Organization of training (full-time trainers, part-time trainers)	Social inclusion
Economic sector		Measures to promote transparency
Status of the enterprise (branch, independent company)		Inclusion into the expert culture
		Complexity of tasks
		Variety of tasks
		Autonomy
		Matching of demands and skills
		Relevance of tasks

Table 4.6 Context variables of the vocational school

School environment	Pedagogical context data	Work process orientation
Size of the school and the vocational department	Teacher/student ratio	Connection of teaching and professional practice
Age structure and composition of teaching staff	Cooperation among teaching staff	Cooperation of learning venues
	School culture (student orientation and deviant behavior)	Teacher's overview on professional work
	Individual support	Acceptance of the school by the training enterprise
	Self-reliance of learners	
	Teaching attitudes	

work tasks depends on the size of the company. In the COMET project, we made the decision to use the MIZEBA tool, on the learning situation in enterprises (Bremer and Haasler 2004; Bremer and Jagla 2000). As some of the MIZEBA scales did not replicate at psychometically convenient levels at the COMET project, we then decided to concentrate on MIZEBA's core items additionally to items developed and tested in the COMET project. The scales that are surveyed by the instrument are described in Table 4.5.

4.2.3 Characteristics of the Vocational Schools

The analysis of the characteristics of the vocational schools takes place by surveying the views of trainees (Table 4.6). The scales that are used have been validated in several projects on the quality of schools conducted by the DIPF (Gerecht et al. 2007). Not the complete inventory was used, however, but only such items that were adequate for the specific situation of vocational schools. For instance, the involvement of parents plays a less important part in vocational schools than in general

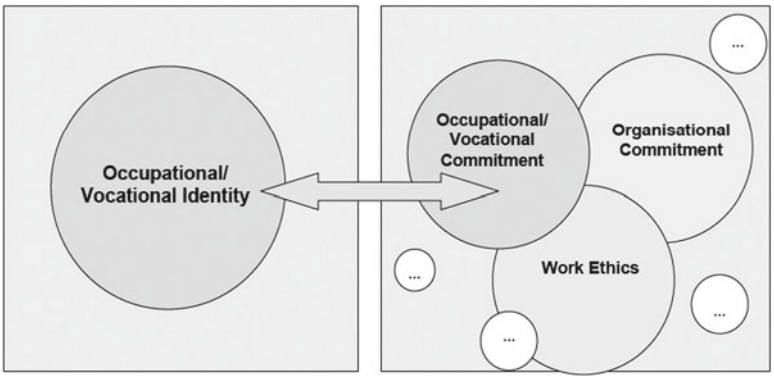

Fig. 4.1 Professional identity and reference centers of commitment

schools. Some items were added that referred to specifically vocational dimensions of teaching quality, e.g., cooperation of learning venues and practice orientation (Pätzold et al. 1998; Pätzold and Walden 1995).

One hypothesis to be tested with regard to the relationship between professional competence development and the learning environment in the vocational school would be that a school environment characterized by high pedagogical quality and a high degree of work process orientation supports a coherent competence development process for all three concepts of professional competence (functionality; utility and customer orientation; social relevance). The first step would be to identify and quantify the impact of single conditions on the process of competence development. It is also possible to monitor the replacement of a "school-based learning concept" by a "vocational learning concept" in the course of the training programme.

4.3 Development of the Commitment Scale

In Chap. 2, it was explained that the assessment of professional competence has to take into account professional identity as well. This is due to the fact that the development of competence cannot take place without a corresponding process of developing a professional identity in the course of vocational socialization processes. Moreover, the development of professional identity is a goal of vocational education in itself and a prerequisite for a modern, process-oriented business culture.

The development of competence as well as of professional identity depends on the willingness of the learners. This commitment can be motivated by several sources, e.g., loyalty to the occupation, to the company, or to work in general. We assume that these different normative points of reference for commitment have themselves an impact on the development of competence and identity (see Fig. 4.1).

Table 4.7 Items for the investigation of professional identity

I like to know in what way my work contributes to the operations of the company as a whole.
In my view professionalism means to deliver quality.
I am fully devoted to my professional activity.
I know what the tasks I fulfill have to do with my occupation.
I sometimes think about how to change my work so as to improve performance or quality.
I would like to have a say about the contents of my work.

Three types of commitment can be distinguished:

- Occupational commitment: this type of commitment is based on the identify-cation with the occupation or the affirmation of one's professional identity (Cohen 2007).
- Organizational commitment: this type of commitment in the work process is motivated by the emotional linkage with the company.

A third type is commitment to work in general, regardless of its actual content. Carlo Jäger (1989) analyzed the impact of such a work ethics (its development famously described by Max Weber) in relation to a commitment orientated towards a profession.

In order to assess commitment and professional identity, four different scales were developed. These were tested first at vocational schools in Hessen and then in a second pretest in Bremerhaven with 1,640 trainees from more than 50 occupations.

Given that *professional identity* always refers to an occupation, it was impossible to develop a scale that would be based on hypotheses on the occupation-specific content of this identity. This would also have undermined the comparability of professional identity as a dimension of professional competence in general. Instead, the scale refers to those dispositions that correspond to the advancement from novice to expert and that lead to professional aptitude. To this end three aspects were identified: the interest in the connection of one's own activities with the professional or organizational context (orientation), the interest in participating in the shaping of work and technology (shaping) and the interest in a highly proficient exercise of one's own work (quality) (Table 4.7).

Cronbach's Alpha for this scale is.73, which is a relatively good score for a scale consisting of only six items. This underlines the fact that from the students' point of view the three aspects of "orientation", "determination" and "quality"\' constitute a unity. This estimate is confirmed by the screeplot (Cattell 1966) as shown in the following Fig. 4.2. The screeplot shows the number of different components to which a variety of items can reasonably be reduced. The factor analysis of the six items of "professional identity" clearly shows that the items are loading on one single factor only. The eigenvalues of the remaining factors are smaller than 1; accordingly additional factors would not help to explain the distribution of values. The one-dimensional scale that results for the items on professional identity means that the three aspects of professional identity constitute a whole in the perspective of the trainees.

In addition, three scales were developed for the identification of the normative reference centers of commitment: work ethic, organizational commitment, and occupational commitment.

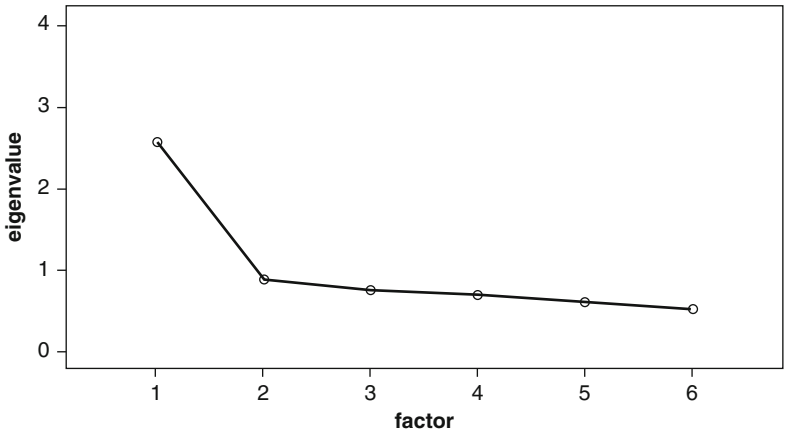

Fig. 4.2 Screeplot for the scale 'professional identity', extraction method: principal components analysis

Table 4.8 Items for the measurement of organizational commitment

For me the company feels a bit like home.
I would like to stay with my company, even when I have the opportunity to move to another employer.
I like to tell others about my company.
I feel only weakly linked to my company. (r)
I 'fit' in the company.
The future of my company is important to me.

With regard to the measurement of organizational commitment, it was possible to build upon the achievements of organizational psychology that were already described in Sect. 2.4. Among the available scales for assessing organizational commitment, especially the widely accepted scale by Meyer and Allen (1991) was used. Here a conceptualization is proposed that refers to the three dimensions "normative", "affective" and "continuance", i.e. loyalty to the organization, an affective commitment to the organization, and the willingness to stay in the organization. Scales like this normally put an emphasis on retention in the organization. However, this motivational anchor is less relevant in the case of trainees because the decision whether they can stay in the company after their training is made by others. Accordingly the items were adapted to the situation of trainees (Table 4.8).

The scale in question has a high internal consistency (Cronbach's Alpha = .87). Furthermore, it is one-dimensional, i.e., the attitudes of trainees to the different items are explained by one single factor (Fig. 4.3).

The second normative area for the explanation of motivation was *occupational commitment*. The scale developed for this field is also based on prior achievements in organizational psychology, especially the "career commitment measure" by Blau (1988) as well as Carson and Bedeian (1994), and the scale on "occupational

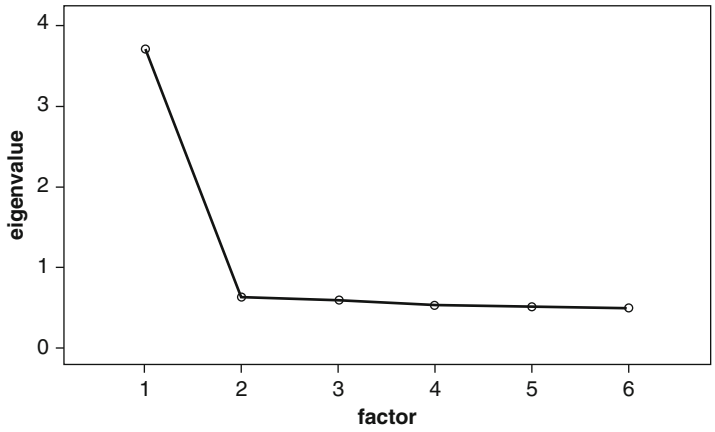

Fig. 4.3 Screeplot for the scale "organizational commitment", extraction method: principal components analysis

Table 4.9 Items for the measurement of occupational commitment

I like to tell others what my profession is.
I 'fit' into my profession.
I have little interest in my profession. (r)
I am proud of my profession.
I would like to continue working in my profession in the future.
For me the profession feels a bit like home.

commitment" by Meyer et al. (1993). The items were once more adapted to the situation of trainees (Table 4.9).

The scale composed of these items also is a good representation of commitment. Cronbach's Alpha here has a value of.87, which again shows a high correspondence of the items. At the same time the scale is one-dimensional, too. The responses to the different items can be attributed to one single factor (Fig. 4.4).

As explained above, *work ethic* can be characterized as an attitude to work irrespective of the concrete occupational contents. The appraisal of work *as such* has a twofold tradition. On the one hand, this attitude corresponds to the extrinsic work motivation required for industrial mass production as described in Sect. 2.4 with reference to the studies by Carlo Jäger. Assignments had to be fulfilled without giving much thought to them. Another tradition was described by Max Weber (1988 [1920]) as the "Protestant ethic". Here a similar attitude emerges from an intrinsic motivation of secular asceticism. In order to measure this type of "Protestant work ethic" composed of work ethic, internalism, and conservatism, Mirels and Garrett (1971) developed the so-called PWE scale. Recent studies show, however, that this scale has lost much of its predictive power in the last decades. In Sect. 2.4 we argued, following Walter Heinz, that in the course of the emergence of "postmaterialist values" the internalization of norms has gradually been replaced by the desire to actively determine the contents of work and the individual career.

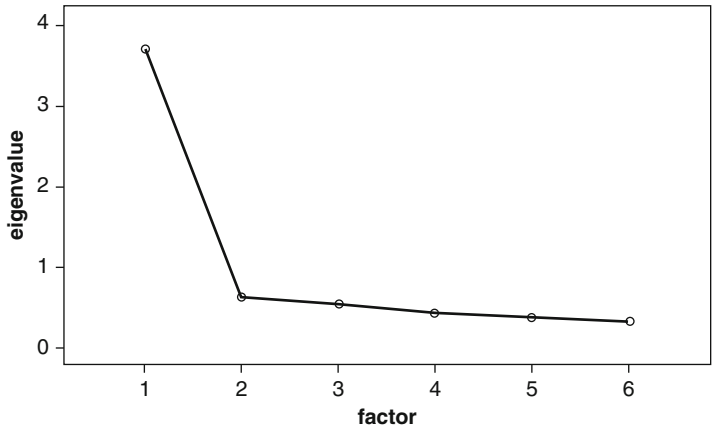

Fig. 4.4 Screeplot for the scale 'occupational commitment'; extraction method: principal components analysis

Table 4.10 Items for the measurement of work ethic

I am motivated no matter what activities are assigned to me.
I am reliable no matter what activities are assigned to me.
I am always punctual even if it is not required for the job.

Accordingly the COMET project did not identify "work ethic" with the Protestant type of work ethic, which would have entailed the risk of associating excessive normative connotations with this concept. Only three items are used to survey punctuality, reliability, and motivation without referring to the concrete contents of occupation and work (Table 4.10). The scale composed of these three items has a relatively low score for Cronbach's Alpha of.52. Given the fact that this index generally tends to have low figures for short scales, this scale is still psychometrically acceptable (cf. Niemi et al. 2004). If the scale was extended to six items like the others with the help of similar items, the result for Cronbach's Alpha would be a score of.70.

The scales were developed with the aim to represent different normative anchor points of commitment. Given that their common point of reference is commitment, they were expected to correlate to some extent, thereby allowing for the identification of trainees with higher or lower levels of overall commitment. Nevertheless, the scales were designed to focus on different dimensions of commitment.

In order to see whether the scales are not only internally coherent, but also selective, the items of the two scales on occupational and organizational commitment were tested by a factor analysis. As there is a connection between the two types of commitment, an oblique rotation was carried out, i.e., the two factors "occupational" and "organizational commitment" were not calculated as orthogonal, mutually independent components. Figure 4.5 shows that the two factors describe clearly distinct areas of commitment.

Only the item "For me the profession feels a bit like home" (OCC_6) is situated between the two principal axes, probably because this item implies a non-specific

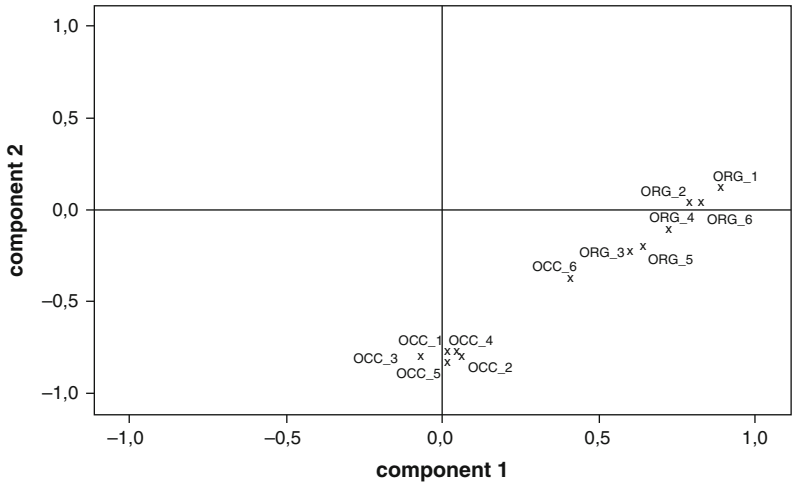

Fig. 4.5 Factor analysis with 12 items of the scales 'occupational commitment' and 'organizational commitment'; extraction method: principal components analysis; criterion: eigenvalue > 1; rotation: oblimin; OCC_1–OCC_6: occupational commitment; ORG_1–ORG_6: organizational commitment

attachment to the occupation. Given that this non-specific aspect is also a part of the identification mechanisms in the course of the socialization into a professional community of practice, it was decided to leave this item in the questionnaire.

When a factor analysis of all items was carried out, the scale for work ethic was split up and did not lead to meaningful results. This is quite interesting with a view to the findings on the changing role of work discussed in Sect. 2.4. The distinction between work ethic and professional ethic in industrial sociology, the debate about postmaterialist values and not least the empirical results on the Protestant Work Ethic Scale coincide in one aspect: the decline of the traditional *work ethic* based on the unquestioned fulfillment of duties. According to the empirical results, it seems to be the case that work ethic alone no longer leads to a consistent attitude towards work and that this normative area is a source of commitment only in combination with other reference points.

4.4 Development of the Assessment Sheet and Operationalization of the Assessment Criteria

The eight criteria for the description and measurement of professional competence need to be operationalized for the practical rating in order to allow for the assessment of solutions proposed for the test assignments. Each of the criteria is operationalized by five items.

Table 4.11 Items for the assessment criterion "utility"

How high is the utility of the solution for the principal or customer?
How user-friendly is the solution for the person who is immediately using/applying/operating it?
Is the aspect of reducing the liability to failure taken into consideration and explained in the solution?
Does the solution take into account and explain aspects of long-term applicability and enlargement opportunities?
Does the proposed solution meet the criterion of easy maintenance and repair?

An example given in Table 4.11 shows how the five items were derived is the criterion of "utility".

The utility of a technical solution can be evaluated from different perspectives. In the first place, this is the perspective of the principal or customer, who decides according to his expectations whether or not the proposed solution is useful. The direct user of the technical appliance, who is not necessarily the customer, but for example an employee who has to operate a milling machine, is in the focus of the second item. It has to be assessed how high the utility is for the target group that ultimately has to work with the solution.

The topic of the third item is an aspect of utility that extends beyond the functioning of a technical solution at the time of delivery or during the period of application. What is assessed here is whether the prevention of a liability to failure has been realized in the solution. It is important that the candidate who worked out the proposal does not only consider this aspect in the solution, but also gives an explanation. The formulation "taken into account and explained" that is frequently used in the items is an expression of the explanatory knowledge (know how) that is expected from future skilled workers.

The utility of technical solutions is often associated with long-term applicability and opportunities for enlargement. With respect to sustainability it is important that solutions aim at an intelligent product life cycle and avoid unnecessary restrictions of the applicability. Therefore, the connectivity with a view to further enlargement is also an aspect of the utility of a solution.

Easy maintenance and repair is an aspect of utility that is addressed by the fifth item. For instance, good accessibility of the lubricant valves at a roller is an important aspect of utility for the user. Repair-friendly solutions are also characterized by easy access during assembly or disassembly without the need to use special tools or to disassemble large parts of the machine only for the routine replacement of a worn-out part. The choice of components also characterizes a user-friendly solution. A standardized component can usually be made available faster and at lower costs than a customized part, which has to be manufactured as a single piece and which is often more complicated to assemble.

The four-point rating scale was found easy to handle in the pretest. The number of distinctions allows for a sufficient differentiation of the ratings (Table 4.12):

The meaning of the rating scale is explained in the assessment sheet so that the rater can give a clear assessment of the characteristics (cf. Porst 2000; Kirchhoff 2001).

Table 4.12 Rating scale of the assessment sheet

The requirements are …	Fully met	Met for the most part	Not met for the most part	Not at all met
Points	3	2	1	0

The bipolar rating scale prompts the rater to make a clear decision on the tendency of the rating. A further differentiation of the scale in more than four levels was avoided in order not to ask too much from the raters and to keep the rating procedure simple.

With regard to the operationalization of the rating criteria, there is the fundamental question as to whether it is possible to develop items that are applicable for a broad range of occupations from a variety of domains. This question can be answered only after the application of the assessment sheet in other occupations. What is certain now is only that the items whose formulations do not refer to specific occupations or occupational fields could be applied by the raters to occupation-specific competences without much difficulty.

4.5 Design of the Large-Scale Survey

The COMET project involves the implementation of a longitudinal survey according to a randomized cross-over design. The following five complexes of variables are studied:

- Criteria of professional competence development, which are surveyed by sets of evaluation tasks on a paper and pencil basis and evaluated in a rating procedure
- Personal characteristics (e.g., demographic variables, prior knowledge, current test motivation)
- Professional identity and commitment
- Characteristics of the learning environment in the training enterprises
- Characteristics of the learning environment in the vocational schools.

The longitudinal study is confined to two test dates with a distance of about a year between them. The strength of the professional identity and the occupational commitment is measured as well. The first test takes place approximately after one and a half years of training. At this time after 18–24 months of training a certain level of professional competence development can be expected that can be evaluated against the training objective of professional aptitude, even though the latter is probably not fully developed at this moment (Fig. 4.6).

In *Phase I* (August 2007–July 2008), two test groups participated in the project. The cohort that started training in summer 2006 as well as the cohort that started 1 year earlier in summer 2005 were covered by samples. This design makes it possible to measure differences in the development of professional competence and professional identity that emerge during 1 year of training.

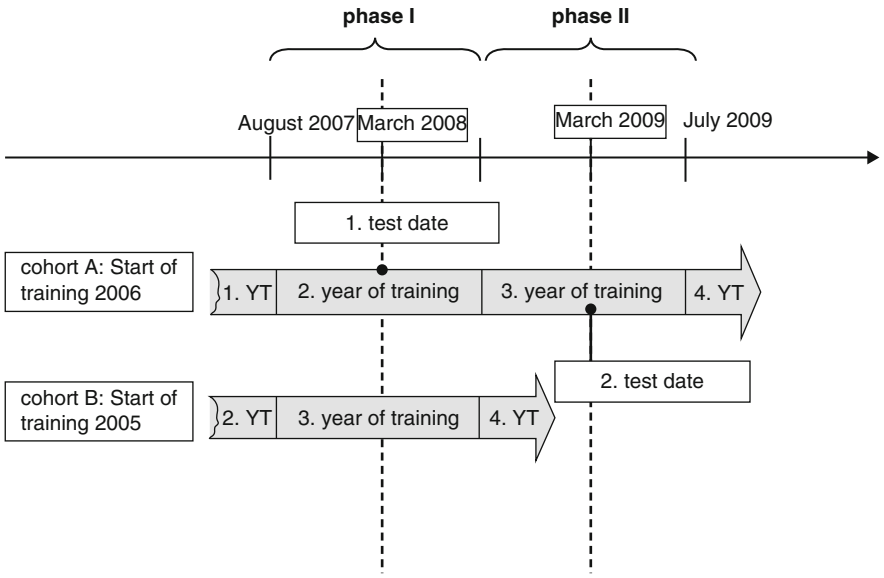

Fig. 4.6 Test dates in combined synchronic and diachronic perspective ("*YT*" means "year of training")

The selection of the two test dates in the second half of the second and third year of training took place with the aim to use test assignments that make it possible to evaluate the professional competence of trainees against the professional aptitude defined in the occupational profiles. This is to say that the benchmark for the development of test assignments is the level of advanced professional aptitude. At the same time the test assignments were formulated in such a way that trainees of the following training cohort would also have the opportunity to develop solutions for these open assignments.

The limitation to only two test dates within a 42-month training programme was mainly due to economic considerations. The rating of test assignments in a large-scale assessment requires considerable manpower as the evaluation of a solution takes about 15 min on average. The employment of teachers as raters by the leave of the authorities in charge made it possible to organize two test dates. If the longitudinal study were to be extended over the entire training period, featuring three or four tests, the workload would be much higher.

For the practical assessment of professional competence, the trainees were allocated at random to two subgroups. As described above, two sets of assignments that were fully comparable in terms of structure and difficulty were developed for the two groups. After one more year of training, i.e., at the second test date, the trainees work on the complementing set of assignments. On the whole the trainees are thus confronted with two sets with a total of four assignments. This cross-over design (see Fig. 4.7) is necessary in order to identify the differential growth in professional competence without using the same set of assignments.

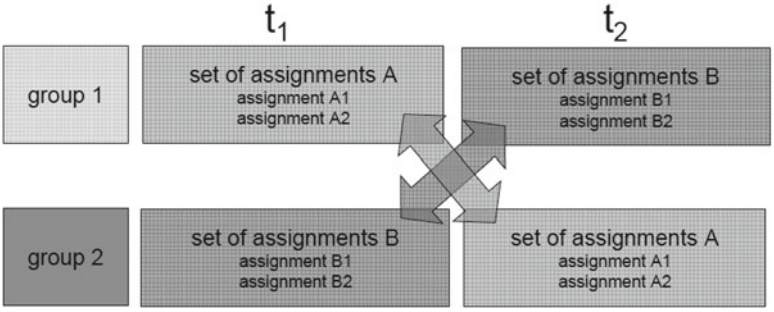

Fig. 4.7 Cross-over design for the use of the test assignments in the longitudinal study

References

Blau, G. J. (1988). Further exploring the meaning and measurement of career commitment. *Journal of Vocational Behaviour, 32*, 284–297.

Bremer, R., & Haasler, B. (2004). Analyse der Entwicklung fachlicher Kompetenz und beruflicher Identität in der beruflichen Erstausbildung (pp. 162–181). Weinheim: Beltz. *Zeitschrift für Pädagogik*, *2*.

Bremer, R., & Jagla, H.-H. (Hg.). (2000). *Berufsbildung in Geschäfts- und Arbeitsprozessen. Dokumentation und Ergebnisse der Fachtagung vom 14. und 15. Juni 1999 in Hannover*. Bremen: Donat.

Butler, P., Felstead, A., Ashton, D., Fuller, A., Lee, T., Unwin, L., & Walters, S. (2004). *High performance management: A literature review*. Leicester: University of Leicester.

Carson, K. D., & Bedeian, A. G. (1994). Career commitment: Construction of a measure and examination of its psychometric properties. *Journal of Vocational Behavior, 44*, 237–262.

Cattell, R. B. (1966). The scree test for the number of factors. *Multivariate Behaviorial Research, 1*, 245–276.

Cohen, A. (2007). *Dynamics between occupational and organizational commitment in the context of flexible labour market: A review of the literature and suggestions for a future research agenda* (ITB Forschungsbericht 26/2007).

Gerecht, M., Steinert, B., Klieme, E., & Döbrich, P. (2007). *Skalen zur Schulqualität: Dokumentation der Erhebungsinstrumente. Pädagogische Entwicklungsbilanzen mit Schulen (PEB)*. Frankfurt a. M.: Gesellschaft zur Förderung Pädagogischer Forschung. Deutsches Institut für Internationale Pädagogische Forschung.

Jäger, C. (1989). Die kulturelle Einbettung des Europäischen Marktes. In M. Haller, H.-J. Hoffmann-Novottny, & W. Zapf (Hrsg.), *Kultur und Gesellschaft* (pp. 556–574). Frankfurt/Main: Campus Verlag.

Kirchhoff, S. (2001). *Fragebogen: Datenbasis, Konstruktion und Auswertung*. Opladen: Leske + Budrich Verlag.

Klieme, E., & Hartig, J. (2007). Kompetenzkonzepte in den Sozialwissenschaften und im erziehungswissenschaftlichen Diskurs. In M. Prenzel, I. Gogolin, & H.-H. Krüger, (Hrsg.), Kompetenzdiagnostik. *Zeitschrift für Erziehungswissenschaft Sonderheft*, *8*, 11–29.

Laur-Ernst, U., Gutschmidt, F., & Lietzau, E. (1992). Neue Fabrik-Strukturen – Veränderte Qualifikationen. Ergebnisse eines Workshops zum Forschungsprojekt „Förderung von Systemdenken und Zusammenhangsverständnis – konkretisiert für Lernen und Arbeiten in Komplexen Fertigungsprozessen“. In P. Dehnbostel, H. Holz, & H. Noack, (Hrsg.), *Lernen für die Zukunft durch verstärktes Lernen am Arbeitsplatz* (pp. 319–332). Berlin: Bundesinstitut für Berufsbildung.

Meyer, P. J., & Allen, N. J. (1991). A three-component conceptualization of organizational commitment. *Human Resource Management Review, 1*, 61–89.

Meyer, P. J., Allen, N. J., & Smith, C. A. (1993). Commitment to organizations and occupations: Extension and test of a three-component conceptualization. *Journal of Applied Psychology, 78*, 538–551.

Mirels, H., & Garrett, J. (1971). The Protestant ethic as a personality variable. *Journal of Consulting and Clinical Psychology, 36*, 40–44.

National Automotive Technicians Education. (1996). *ASE certification for automobile technician training programs*. Herndon: National Automotive Technicians Education.

Niemi, R. G., Carmines, E. G., & McIver, J. P. (2004). The impact of scale length on reliability and validity. *Quality and Quantity, 20*(4), 371–376.

Pätzold, G., & Walden, G. (1995). *Lernorte im dualen System der Berufsausbildung*. Bielefeld: W. Bertelsmann.

Pätzold, G., Drees, G., & Thiele, H. (1998). *Kooperation in der beruflichen Bildung: zur Zusammenarbeit von Ausbildern und Berufsschullehrern im Metall- und Elektrobereich*. Baltmannsweiler: Schneider-Verlag Hohengehren.

Porst, R. (2000). *Question wording – zur Formulierung von Fragebogen-Fragen*. Zentrum für Umfragen, Methoden und Analysen (ZUMA) How-to-Reihe, Nr. 2, Mannheim.

Rauner, F., & Haasler, B. (2001): *Berufsbildungsplan für den Werkzeugmechaniker* (ITB-Arbeitspapiere Nr. 30). Bremen: Institut Technik und Bildung der Universität.

Ripper, J., Weisschuh, B., & Daimler Chrysler, A. G. (1999). *Ausbildung im Dialog: das ganzheitliche Beurteilungsverfahren für die betriebliche Berufsausbildung*. Konstanz: Christiani.

Skule, S., & Reichborn, A. N. (2002). *Learning-conducive work. A survey of learning conditions in Norwegian workplaces*. Luxembourg: Office for Official Publications of the European Communities.

Weber, M. (1988). Die ‚Objektivität' sozialwissenschaftlicher und sozialpolitischer Erkenntnis. In M. Weber (Hrsg.), *Gesammelte Aufsätze zur Wissenschhaftslehre* (First print 1922, pp. 146–214). Tübingen: Mohr.

Zimmermann, M., Wild, K.-P., & Müller, W. (1999). Das „Mannheimer Inventar zur Erfassung betrieblicher Ausbildungssituationen" (MIZEBA). *Zeitschrift für Berufs- und Wirtschaftspädagogik, 95*, 373–402.

Chapter 5
Test Instruments and Implementation of the COMET Study

The development and selection of the test instruments is largely determined by the research objectives as well as project-immanent considerations (see Chap. 1). In addition, the experience from the pilot phase of the project (2008) was taken into account in the further development of the research methods and instruments. Table 5.1 shows the test instruments that were introduced at the first (2008) and second test date (2009).

5.1 Instruments at the First Test Date

5.1.1 Open Test Tasks

The main instrument of the COMET study consists in the four open test tasks. Their structure corresponds to the processing of orders in the practice of professional work and represents the training objectives defined in the training regulations. Each participant at the first test date works on two test tasks. The amount of 2×120 min for the processing of two complex open test tasks makes it possible to measure professional competence in such a way that the specific qualifications of a skilled worker as described in the occupational profile are adequately represented.

The development of the test tasks was in the focus of the preparation of the study. All people involved were aware that the preparation of the raters for the assessment of the proposed solutions and especially the interrater reliability would be the first test for the project. Within the project consortium this objective was considered very demanding, given that such an accomplishment required the understanding and acceptance of the competence model with its conceptual framework and the ensuing rating scale with its 40 items. This turned out to be surprisingly unproblematic.

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DOI 10.1007/978-94-007-4725-8_5,

Table 5.1 Test instruments introduced at the first (t_1) and second test date (t_2)

Test instrument	Introduced at test date
Open test assignments	t_1 (2008)
Context survey questionnaire	t_1 (2008)
Questionnaire on the test motivation of trainees	t_2 (2009)
Teacher questionnaire on the test motivation of trainees	t_2 (2009)
Rater questionnaire on the weighting of competence criteria	t_2 (2009)
Test of cognitive ability	t_2 (2009)

The theoretical foundations of the competence model were regarded as a firm basis for vocational education and training. Therefore, learning tasks were developed on the basis of the competence model alongside the development of test tasks already during the pilot phase. In addition, the rating scale by which the eight competence criteria are operationalized was successfully used as a tool for the self-evaluation of teaching projects by the trainees. The high acceptance of the competence model and the rating scale had a positive effect on the interrater reliability. In addition to the competence model and the rating scale, the raters were also equipped with a solution space for each test assignment. The solution space describes what possible solutions and variants are associated with the open test assignments.

Difficulties were also expected with regard to the introduction of the concept of *professional validity* and the corresponding need for the teachers to view the *curricular validity* of test assignments as a less important criterion. However, the expectation that especially those teachers who had been involved in the development of framework curricula would also prefer to use the latter as a yardstick for the test development turned out to be wrong.

The experience gathered during the development of test assignments makes it possible to formulate some requirements for the experts involved in the test development. They need to

1. Have an in-depth understanding of the competence model
2. Be familiar with the relevant professional practice in its scope and depth (this includes knowledge of the fields of application for the occupation in question)
3. Be willing to distance themselves emotionally and intellectually from their own practice of vocational education and to reflect this practice critically
4. Be able to reflect on professional qualifications and competences across learning venues and from the perspective of professional action competence
5. Be able to estimate the future development of occupations in the sector

In the COMET project, these requirements were met thanks to the professional and didactical competence of the teachers in the coordination team.

During the pilot phase and especially during the development and testing of test assignments, the question was repeatedly discussed what results of competence diagnostics might be expected from the COMET project as opposed to the results of examinations (intermediate and final examinations) and learning assessment in the vocational school. Only if it can be demonstrated that a “large-scale” competence

Table 5.2 Content dimensions of the context questionnaire

Personal characteristics of the learners	Characteristics of in-company training	Characteristics of the vocational school
Socio-economic background	General characteristics of the enterprise	School environment
Educational attainments and previous learning pathway	Work process orientation of the training program	Pedagogical context data
Motivation for training	Training situation in the enterprise	Work process orientation

diagnostics has an epistemic potential that is not equaled by the two other ways of evaluating vocational learning outcomes so that significant insights for the design and organization of vocational learning processes can be expected, the efforts required for a large-scale competence diagnostics will be justified.

5.1.2 The Context Questionnaire

In addition to the two test assignments, the participants of the first test date were presented a questionnaire that asks about background characteristics of the trainees as well as context variables related to the company-based and the school-based part of the training programme (see Tables 4.2, 4.5). Table 5.2 summarizes the content of the questionnaire.

The purpose of this context survey is to identify potential influential factors with regard to the development of professional competences. Only when the way these factors work is analyzed successfully, there will be the opportunity to draw conclusions for educational policy and practice.

5.2 Extension of the Test Methodology for the Second Test Date

5.2.1 Application of a Non-verbal Test for the Assessment of Basic Cognitive Abilities

From the second test date onwards, the test arrangement was supplemented by a test of general cognitive abilities in order to deliver more exact information about the relationship between basic cognitive abilities and professional competence development. This test is especially an important prerequisite for international comparative studies since the factor “prior school attainments” (school types and learning achievements) is difficult to generalize for such comparisons. Given that from the second test date March/April 2009 the COMET study also includes trainees from China, it is necessary to gain additional information about the cognitive level of these trainees. To this end a subtest of the Cognitive Ability Test (*CAT*) was chosen.

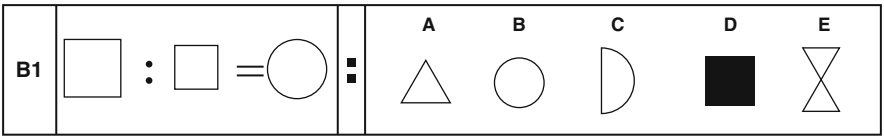

Fig. 5.1 Sample task from the CAT subtest "figure analogies" (Source: Heller and Perleth 2000)

CAT is a differential intelligence test that can be used for pupils and students from the fourth to the twelfth grade and which consists of a verbal, a quantitative, and a non-verbal part. In the COMET project, a subtest from the non-verbal part, the "figure analogies" test, which measures figural-spatial reasoning skills, was used. Given is a pair of figures whose components are standing in a particular relation to each other. The task is to identify, from a set of five alternative figures, the one that is related to a third figure in the same way as the first two (Fig. 5.1).

The working time for this subtest is 8 min. Together with the necessary instruction the total time amount required for the test is approximately 15 min.

This subtest was chosen for several reasons. First of all, the participation of Chinese and German trainees necessitated the selection of a language-neutral test of cognitive abilities. Another advantage is the comparability of the results with the PISA study: The national PISA 2003 supplementary test used the same scale (DPK 2004, 167). The aim was to investigate to what extent basic cognitive abilities are relevant for mathematics as well as for analytic and dynamic problem solving. The latent correlations between the KFT subtest and the PISA scales (reading:.64, mathematics:.74, science:.68) show that a good score in this test is associated with higher mathematical and scientific literacy. In addition, the correlations between the three parts of the test give a reason why the implementation of the complete non-verbal part of the KFT could be left out in order to save time.

5.2.2 Measuring Test Motivation: Survey of Trainees and Test Supervisors

During the pilot phase, the motivation of the participants in the test was not surveyed. However, the feedback from the teachers concerning the test behavior of their students suggests that the motivation is subject to considerable variation. Some of the trainees used the time available for the work on the test only in part. Some others obviously did not take the test assignments seriously. Given the experience of the first test date, it was decided to evaluate the test motivation and test behavior at the second date. The formulation of the questions follows the PISA test practice.

In addition, the teachers who supervised the classes during the tests filled in a questionnaire that collects information about the motivation in the class and the working atmosphere. The teachers give an assessment of the trainees' commitment concerning the work on the test assignments, information about the number of test

absentees, and information about whether and how many questions there were on the part of the students and what aids were used to what extent. These data can be used for the comparison of test results at the class level.

5.2.3 Rater Survey on the Weighting of Competence Criteria

For the competence model, the decision was made to give approximately equal weight to all competence criteria. The competence levels "processual competence" and "holistic shaping competence" are composed of three criteria each while the level of "functional competence" consists only of two criteria, namely "functionality" and "clarity/presentation". These two criteria therefore have more weight within the model than the other six. In order to test the competence model, i.e., the assignment of criteria and items to the levels, a factor analysis was carried out (see Chap. 9). Apart from that, the vocational pedagogues involved have their own ideas about the weighting of competence criteria. Their opinions were surveyed during the second phase of the test with 20 raters each from Bremen, Hessen, and Beijing. This makes it possible to check whether the subjective weighting by the raters has an influence on the rating.

5.3 Participants of the Test Dates

5.3.1 First Test Date (2008)

At the first test date (t_1) in March/April 2008, trainees in Hessen and Bremen were tested who had begun their training in 2006 (test group A06) or 2005 (test group A05) and were in their second or respectively third year of training when the test took place (Fig. 5.2).

The particular quality of this synchronic test is that it also has the features of a quasi-longitudinal study. The trainees of the two cohorts are distributed, on a random basis, across two subgroups of equal size that work on different test assignments as explained in the previous chapter. This "cross-over" procedure allows for a comparison of second and third year trainees and turns the synchronic survey into a quasi-diachronic one.

The fact that the groups are tested at the same date (t_1) has the side effect that for the two test groups similar training conditions obtain. However, the comparative study does not include the opportunity to investigate whether and how the results of the competence test influence the implementation of new teaching and learning methods and thus the process of competence development. This, however, is one of the core objectives of the COMET project. The results are intended to support new teaching and learning methods with a view to a school instruction that is structured by learning areas. Therefore, it is only with the help of genuine longitudinal studies that the effects of the desired innovation on the competence development of the trainees can be investigated.

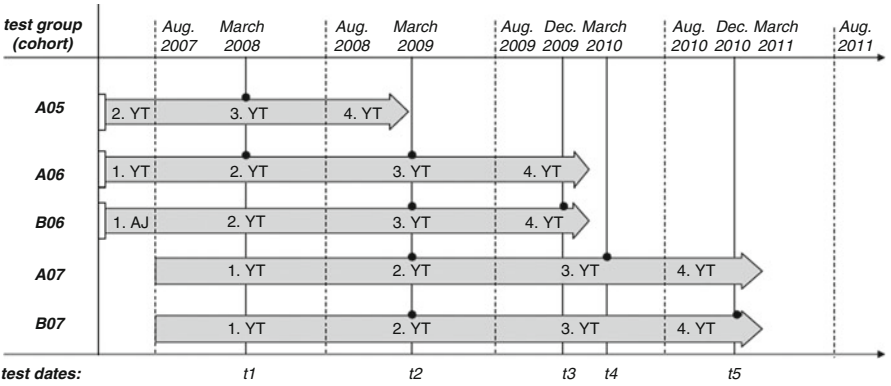

Fig. 5.2 Simplified test scheme with five test dates ("*YT*" means "year of training")

5.3.2 Second Test Date (2009) and Extension of the Study by Additional Test Dates

The second test date (March/April 2009) features four test groups. The trainees from group A06, who are now in their third year of training, already participated in the first test date. The comparison of the results of this group at the test dates t_1 and t_2 is a longitudinal survey and makes it possible to identify the competence development of each trainee in this group individually. This also includes the opportunity to draw a distinction between trainees whose teachers already took the results of the first test into account for new learning approaches and trainees whose teachers did not find the time to do so.

The test groups A07 and B07, composed of second-year trainees, are participating for the first time at test date t_2.

Another group participating for the first time was a group of approximately 100 third-year trainees (group B06), who had not been tested at the first date t_1. The reason was the extension of the study by an additional test date: The trainees of the groups B06 and B07 were to be tested anew in the fourth year of training (t_3: December 2009; t_5: December 2010). The extension of the longitudinal study by further test dates was motivated by the insight that the time-schedule of the examinations has an impact on the competence development. The test dates t_3 and t_5 were embedded in the final examination. It was expected that the results at this dates would show whether and to what extent the punctual examination has an effect on the trainees' competence development. Comparing the results of test group B06 makes it possible to measure the competence development in the period from April to December 2009 (t_2 and t_3). The particular relevance of this period lies in the fact that for the group B06 the test date t_2 fell within a period where no assessment took place whereas t_3 coincided with the second part of the final examination. In order to achieve a broader empirical basis for the study, the group B07, which was tested at the dates t_2 and t_5, and the group A07,

which was tested at the dates t_2 and t_4, participated in the longitudinal study with the aim to gather additional data on the question whether and how periods with and without examinations had an impact on competence development.

5.4 The Training Enterprise as an Alternative Test Location

In the evaluation meetings with the teachers, the hypothesis was put forward that the vocational school as the location where the tests were carried out might influence the trainees' problem-solving approach and motivation. According to this quite plausible reasoning, the trainees' approach to potential solutions could be shaped in the sense that trainees automatically adopt the perspective of an "academic" concept of learning when exposed to a school environment. This would have the effect that the subjective solution space for the test assignments is narrowed to the dimension of functional competence. Indeed, this cannot be excluded beforehand, given that the concept of learning areas is not always fully implemented in the vocational school. Therefore, the test results can also be interpreted as an indicator for the successful implementation of the concept of learning areas. Accordingly, the test behavior and the subjective solution spaces may be positively influenced by carrying out the competence test in the training enterprise. In order to test this hypothesis empirically, the second test date included an experimental investigation. One of the process engineering classes in Bremen took the test in a large enterprise.

5.5 Analysis of the Test Results

The individual test scores are calculated on the basis of two open complex test tasks with a working time of 2×120 min. The rating of the solutions is carried out by two teachers independently of each other. Each of the eight criteria is operationalized by five items.

As explained in the previous chapter, the raters evaluate the extent to which an item is fulfilled on a four-level scale. Table 5.3 gives an example of how the ratings are transformed into points.

The sum of the average ratings is divided by the number of items so that for the functionality criterion the mean is 2.4. The mean for each criterion is rounded to one digit after the decimal point and multiplied by 10. For the example presented in Table 5.3 the final result is therefore a score of

$$P_{\mathrm{F1}} = 24.0$$

The scores for the competence levels are calculated as arithmetic means of the competence criteria that define the levels (Table 5.4).

Table 5.3 Example of the calculation of points for the criterion of functionality

	Rater 1	Rater 2	Average
Item 1	3.0	3.0	3.0
Item 2	2.0	2.0	2.0
Item 3	2.0	3.0	2.5
Item 4	3.0	2.0	2.5
Item 5	2.0	2.0	2.0
Total			12.0

Table 5.4 Calculation of the scores for the three competence levels

Competence level	Competence criteria	Scores (competence criteria)	Scores (competence level)
Holistic shaping competence (K_G)	8	P_{G1} 11	P_G 12.0
	7	P_{G2} 13	
	6	P_{G3} 12	
Processual competence (K_P)	5	P_{K1} 18	P_P 17.3
	4	P_{K2} 16	
	3	P_{K3} 18	
Functional competence (K_F)	2	P_{F1} 24	P_F 22.5
	1	P_{F2} 21	
Professional competence			P_Σ 51.8

Given that each participant was working on two assignments, the rule that applied at the first test date was that the mean of the results of the two assignments was used to calculate the individual scores of the participants. However, this practice was abandoned at later stages of the project and only the results for the first test assignment were taken into account. As will be explained in more detail in the subsequent chapters, the reason was that a decline in motivation was observed between the first and the second assignment, which compromised the scientific value of the data delivered by the latter.

The individual data of test persons can be aggregated by different criteria such as classes, school locations, prior educational attainments of trainees, etc.

According to the definitions outlined above, the distinction "fully realized" is equivalent to a score of ≥22.5 points (with a maximum of 30 points). In the assessment practice, a (partial) examination is considered as "pass" when at least 50 % of the points required for the highest interval were reached. In our case, the threshold for the highest interval is 22.5 points. According to the 50 % principle, the minimum score for the attainment of a competence level is thus set at 11.3 points.

The individual achievements of the participants are allocated to the competence levels according to a criterion-based interpretation of the solutions. The basis for this interpretation is the competence model described in Chap. 3 (Fig. 5.3).

In order to interpret the test results for the individual participant, two indicators are calculated:

1. The overall score reached in the test
2. The competence level

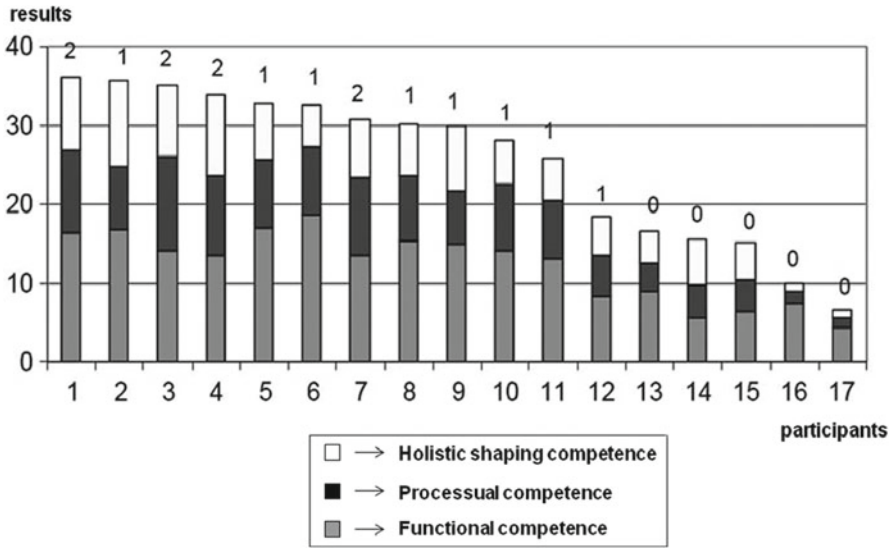

Fig. 5.3 Example of 17 participants and their test results (the number *above the columns* indicate the level of competence of each participant)

In the course of the analysis of the test results, it was investigated whether the level of *functional competence* can be presupposed as a basic condition for the other competence levels. The results suggest that each of the alternative interpretations – progressive competence levels or independent competence dimensions – is plausible to some extent. As the results of the latent class analysis show, it is reasonable to assume that the difficulty of the competence dimensions is increasing (cf. Chap. 9). On the other hand, the analyses have shown that the contents of the dimensions are independent of each other so that it makes sense to regard them as different dimensions.

With regard to the allocation of the trainees' achievements to competence levels, the following definitions were agreed within the COMET consortium.

Competence level 0 – nominal competence: The participants who only attain this level do not yet have *professional* competence. This is always the case when the conditions for the attainment of the first competence level are not met. In Fig. 5.3, this applies to the test persons 13–17.
Competence level 1 – functional competence: In order to attain this competence level the following conditions must be met:

1. A test person reaches competence level 1 when the score for functional competence is higher than 11.2 and when the conditions for the attainment of level 2 are not fulfilled.
2. If the score for functional competence is smaller than or equal to 11.2, the missing points up to a score of 8.3 can be compensated by points reached in

Table 5.5 Rules for the compensation of missing points in functional competence

Score for "functional competence" (P_F)	Minimum scores required for processual and holistic shaping competence in order to reach competence level 1 ($\sum(P_P+P_G)$)
10.3–11.2	3
9.3–10.2	6
8.3–9.2	9
≤8.2	No compensation possible

Table 5.6 Rules for the compensation of missing points in processual competence

Score for "processual competence" (P_P)	Minimum score required for shaping competence in order to attain competence level 2 (P_G)
10.3–11.2	3
9.3–10.2	6
8.3–9.2	6
≤8.2	No compensation possible

the two other dimensions "processual competence" and "holistic shaping competence". Table 5.5 shows the rules that apply in this case.

3. If the score for functional competence is smaller than 8.3, there is no possibility whatsoever to attain competence level 1, as shown in Table 5.5.

In Fig. 5.3, the participants 2, 5, and 6 as well as 8–12 accordingly reach the first competence level.

Competence level 2 – processual competence: In order to attain this competence level, the following conditions must be met:

1. A test person reaches competence level 2 when the score for functional competence as well as the score for processual competence are higher than 11.2 points each and when the conditions for the attainment of level 3 are not fulfilled.
2. If the score for processual competence is smaller than or equal to 11.2, the missing points can be compensated according to the principles of the first level by points reached in the dimension of "holistic shaping competence". Table 5.6 shows the rules that apply in this case.
3. If the score for processual competence is smaller than 8.2, there is no possibility whatsoever to attain competence level 2, as shown in Table 5.6.

In Fig. 5.3, the participants 1, 3, 4, and 7 are the ones who attain the second competence level.

Competence level 3 – holistic shaping competence: The third level is attained by those participants who reach more than 11.2 points for each of the three competence dimensions. In Fig. 5.3, none of the participants meets this condition.

The test results can be visualized in different ways. The presentation in Fig. 5.3 summarizes the results of one class.

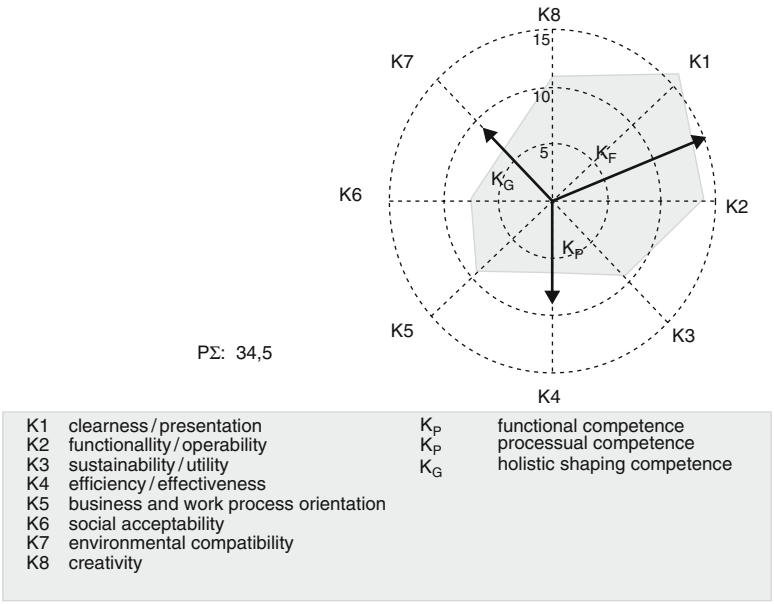

Fig. 5.4 Example of a competence profile

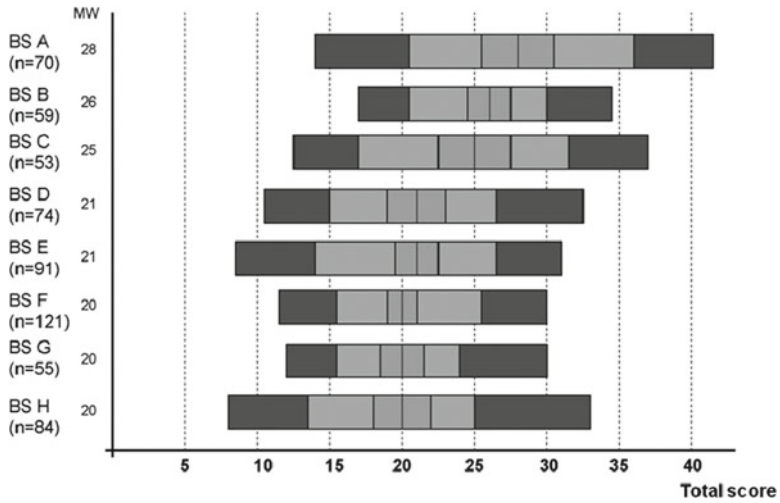

Fig. 5.5 Example of a comparative presentation of competence distributions ("*MW*" means "arithmetic average")

In addition, a radar chart is created for each participant (Fig. 5.4). This presentation, which shows not only the three competence levels but also the eight competence criteria, emphasizes the multidimensional character of the competence model.

It is also possible to compare the average scores of different groups by means of percentile bands (for detailed explanation see Sect. 7.3). This method is appropriate for benchmarking studies and is also used in the PISA publications (Fig. 5.5).

Reference

Heller, K. A., Perleth, Ch. (2000). *Kognitiver Fähigkeitstest (KFT 4-12+R)*. Weinheim: Beltz.

Chapter 6
Results 2008: The Survey Population

6.1 Selection of the Sample and Survey of the Context Data

Approximately 700 trainees for the occupations of "electronics technician for power engineering and building systems" (crafts) and "electronics technician for process engineering" (industry) are participating in the COMET study. The first of these occupations is trained in the crafts sector while the second one is trained in the industrial sector. Whereas in Hessen it was necessary for economic reasons to draw a representative sample of about 400 trainees from both occupations, the small-scale environment in Bremen allows for a census with approximately 300 trainees.

The six vocational schools in Hessen that take part in the COMET project train students in these two occupations. The sample includes schools in urban areas such as Kassel and Frankfurt as well as schools from rural areas. The entire survey population includes approximately 350 participants from the second training year and 350 participants from the third year. The rating of the test solutions was carried out by 18 VET teachers from Hessen and 13 teachers from Bremen.

One of the core objectives of competence diagnostics, especially in the case of large-scale studies, is not only to depict the results or the course of competence development processes, but also to contribute to the identification of the relationship between the context of vocational training processes and their course. Projects like this can fulfill an evaluative function only if different design parameters are investigated with regard to their effects on the development of professional competence. The information about the effects of these parameters can then be used for conclusions in education policy and practice. The context of vocational training processes is defined by the learning venues of vocational education. The interpretation of the competence development processes documented by the test assignments thus requires that the context features of vocational learning as described in Chap. 4 be surveyed as independent variables. These are the personal characteristics of learners, the characteristics of training enterprises and the characteristics of the vocational schools.

F. Rauner et al., *Competence Development and Assessment in TVET (COMET)*, Technical and Vocational Education and Training: Issues, Concerns and Prospects 16,
DOI 10.1007/978-94-007-4725-8_6, © Springer Science+Business Media Dordrecht 2013

6.2 Personal Characteristics of the Trainees

At the time of the first survey (summer 2008 in Hessen, November 2008 in Bremen), the majority of the trainees is 18–19 years old. Due to the fact that some of the trainees are already between 25 and 30, the average age is about 20 years. The trainees in process engineering (industry) are on average 19.7 years old and thus about 10 months younger than the trainees in power engineering and building systems (crafts) (20.5 years). The higher average age of the trainees in power engineering and building systems can be explained to some extent by the fact that in this group measures of prevocational education and guidance were more frequently used than in the other group.

As regards the prior educational attainments, the regional differences are small. In Hessen as well as in Bremen, almost three quarters of the respondents have a *Realschulabschluss*, i.e., a medium-level certificate of secondary education. On the other hand, there are significant differences in terms of school qualifications between the two occupations: trainees in process engineering usually have a certificate from medium-level or upper secondary education. It is only 10% who have a *Hauptschulabschluss*, i.e., a certificate of lower secondary education, which also exists in an extended or upgraded version (*erweiterter Hauptschulabschluss*). By contrast, the share of trainees in power engineering and building systems who have a *Hauptschulabschluss* is more than 30%, and two thirds have a *Realschulabschluss.* Among the power engineering trainees in Hessen, the proportion of those with a *Hauptschulabschluss* even exceeds 50% (Fig. 6.1).

In addition, the process engineering trainees with a medium-level school qualification tend to have better marks in mathematics, German, and English than

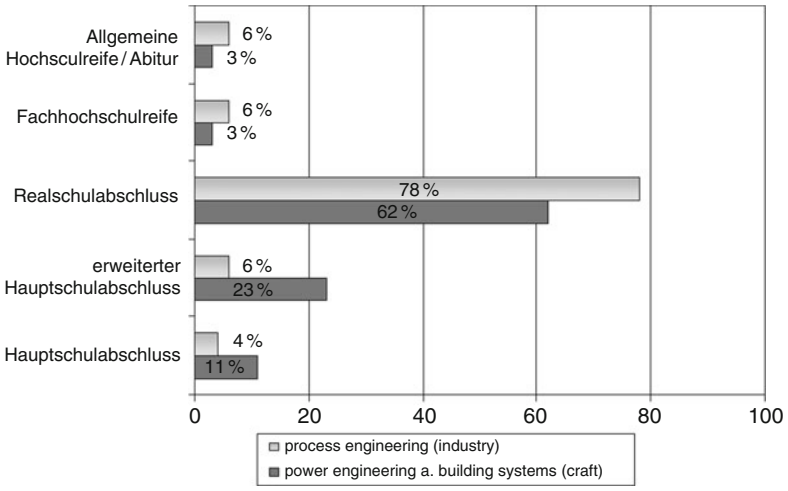

Fig. 6.1 Prior school attainments by occupation

Table 6.1 Population of trainees' places of residence by occupation

	Up to 9,999 (%)	10,000–24,999 (%)	25,000–49,999 (%)	50,000–99,999 (%)	100,000 and more (%)
Process engineering (industry)	28.5	28.0	15.0	4.1	24.4
Power engineering and building systems (crafts)	19.7	23.4	7.3	0.0	49.6
Total	25.3	26.4	12.3	2.6	33.4

their counterparts among the power engineering trainees. The marks of electronics technicians for process engineering in mathematics and German are on average 0.4 points better than those of the other group. In English, the difference is 0.3 points. Enterprises recruiting strategies obviously differ among the branches, industry selecting "better" pupils than crafts sector.

One quarter of the trainees comes from rural areas with less than 10,000 inhabitants, another quarter is living in towns with 10,000–25,000 inhabitants. The proportion of those living in municipalities with 25,000–100,000 inhabitants is 15%, and 33% are living in big cities (Table 6.1).

The comparison of the places of residence by occupation shows that among the trainees in crafts the proportion of those living in big cities is above average (about 50%) while among the trainees in process engineering only one out of four is living in an urban area.

It was emphasized in all PISA studies that the social, economic, and cultural characteristics of the parents are a more or less stimulating feature with regard to the development of competences and the course of the educational pathway (PISA 2005, 236ff.). In order to identify the potential influence on professional competence development, the COMET project investigated particularly the educational background of parents, their possible immigrant status as well as the extent to which parents supported their children in the training process.

Starting from the PISA hypothesis that the acquisition of professional competence might also be impeded when trainees lack a sufficient command of the *language* that is used in the training enterprise and the vocational school, which means that trainees may have to learn the language alongside their training, the COMET project pays special attention to the language spoken at home. This includes the "multilingual" trainees (who use German and other languages to the same extent) as well as "foreign" trainees with an immigrant background (who use predominantly the language of the country of origin).

The COMET data show that immigrants are underrepresented in the two training programmes for electronics technicians. The average is 11.8%. In Hessen, the proportion is almost twice as high (15.4%) as in Bremen (8.6%). When the two training programmes are compared, it turns out that the proportion of young people with an immigrant background is higher in the crafts (15.4%) than in industry (10%). This corresponds to the empirical result that a large proportion of the immigrants has only a *Hauptschulabschluss* and that trainees with this school qualification are

Table 6.2 Predominant language of trainees' parents by occupation

	German (%)	Turkish (%)	Russian (%)	Other language (%)
Process engineering	90.0	3.2	3.2	3.5
Power engineering and building systems	84.6	3.1	4.9	7.4
Total	88.2	3.2	3.8	4.9

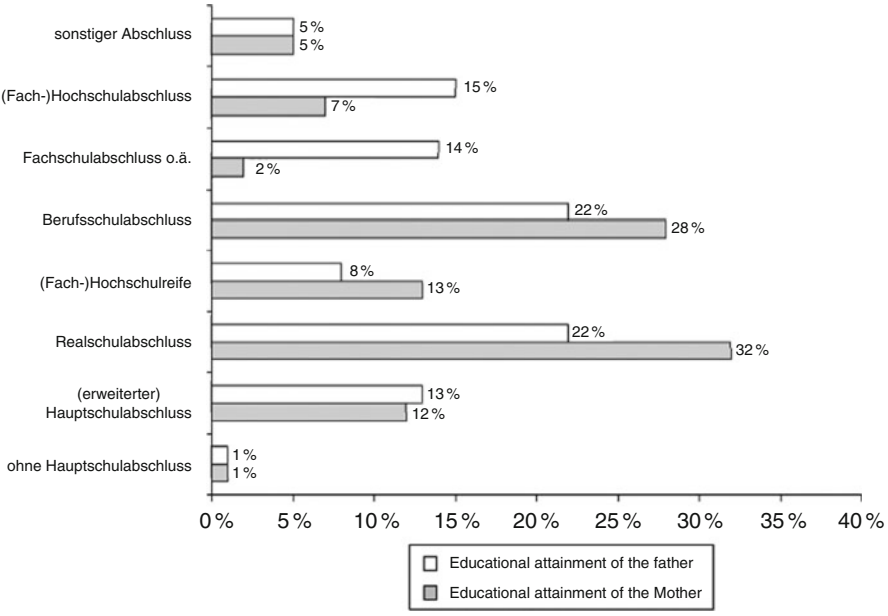

Fig. 6.2 Educational background of parents

stronger represented in the training programme for power engineering and building systems (Table 6.2).

A relatively high proportion of trainees with an immigrant background is found in the programme for power engineering and building systems in Hessen. Here the share is 31.7%.

As regards the *educational attainments of parents,* there are hardly any differences between the qualification level of father and mother. One third of them has acquired a *Realschulabschluss* and completed a vocational education and training programme. Another 13% have a regular or extended *Hauptschulabschluss*, and only 1% have no school qualification at all. However, there are differences with regard to the distribution of higher-level qualifications. The trainees' fathers more frequently than the mothers are in possession of an advanced vocational qualification or a university degree (Fig. 6.2).

The comparison of the two occupations shows that the parents of the prospective electronics technicians for process engineering posses on average a higher educational

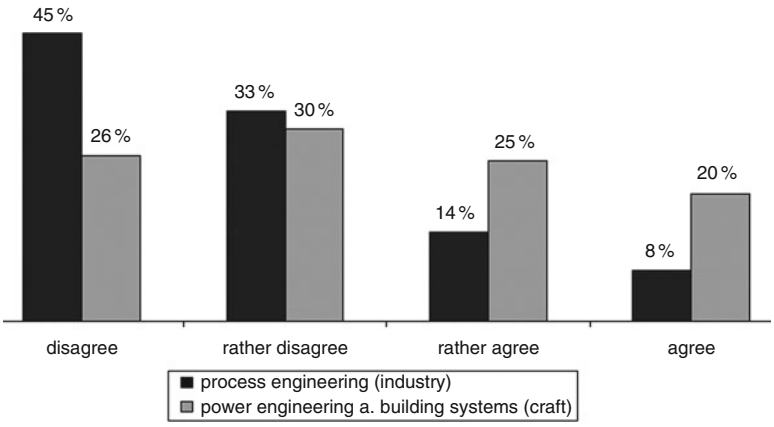

Fig. 6.3 Responses of trainees on the item "I originally wanted to learn another occupation in fact, but I was offered a training place only in this one"

level than the parents of the other trainees. On the whole the vast majority of trainees indicates that their parents are interested in their training and support them. It is only one out of ten trainees who feels that this is not the case.

The occupation of electronics technician continues to be among the 10 most wanted training occupations that are chosen especially by young men (BMBF 2008, 118). In accordance with this fact, only 3% of the trainees surveyed in the COMET project are female.

The majority of respondents (67%) indicates that they always wanted the training occupation they ultimately chose. However, some 30% say that they really wanted to learn another occupation, but were offered a training place only in this one. When the two training programmes are compared, one can observe that especially in the power engineering programme there are many trainees for whom the occupation in question is not the one they first aimed at. Almost every second trainee wanted to learn a different occupation originally (Fig. 6.3).

6.3 Characteristics of the Training Enterprise and the In-Company Training Process

It has to be assumed that the general characteristics of the training company already have some effect on the organization of the training process. For instance, experience shows that the scope of everyday work tasks varies with the size of the company. Another example is the work climate, which can influence the degree to which the training environment actually supports learning.

The practical training of the participants takes place almost exclusively in single enterprises. Only approximately 5% of the trainees indicate that they are trained in cooperation with several partner enterprises.

Table 6.3 Size of training enterprises

	1–4 (%)	5–9 (%)	10–49 (%)	50–99 (%)	100–499 (%)	>500 (%)
Process engineering	1.6	1.9	4.5	3.8	17.9	70.2
Power engineering and building systems	12.3	25.3	44.4	9.9	4.9	3.1
Total	5.3	9.9	18.1	5.9	13.5	47.3

Table 6.4 Trainees' views concerning the work climate

	I strongly disagree (%)	I disagree (%)	I agree (%)	I strongly agree (%)
The employees are closely monitored.				
Process engineering	20.6	57.1	19.0	3.2
Power engineering and building systems	23.0	57.1	14.3	5.6
Total	21.4	57.1	17.4	4.0
When necessary, employees support each other.				
Process engineering	1.3	7.1	46.6	45.0
Power engineering and building systems	0.0	13.8	36.3	50.0
Total	0.8	9.3	43.1	46.7
The colleagues discuss newly arising problems.				
Process engineering	0.0	10.5	58.9	30.6
Power engineering and building systems	0.8	10.2	55.9	33.1
Total	0.4	10.3	57.4	31.8

Significant differences can be identified between the company structures in the industry and crafts sectors. More than two thirds (70%) of the future electronics technicians for process engineering (industry) are trained in large enterprises with more than 500 employees and only 12% are trained in enterprises with less than 100 employees. In the crafts sector the situation is the opposite: The majority of trainees comes from training enterprises (82%) with less than 50 employees, a third of them comes from enterprises with less than 10 employees (Table 6.3).

Given that a cooperative working atmosphere also supports the training process in the company, the trainees were asked about their opinions on this matter (Table 6.4).

According to these data the majority of the trainees rates the working atmosphere as rather cooperative. For example, approximately 90% affirm the statement that the employees support each other and exchange information when problems arise. Nevertheless every fifth trainee holds the view that there is a close monitoring in the training companies.

The key to improving professionalism with a view to quality awareness and responsibility lies in a practice of vocational education that aims not only at the impartation of vocational qualifications, but also at the realization of training conditions that support the integration into professional communities of practice. The development from novice to expert through learning in the workplace is successful

Table 6.5 Trainees' views concerning professional support in the training process

	Very rarely (%)	Rarely (%)	Sometimes (%)	Often (%)	Very often (%)
When I fulfill work tasks on my own I receive professional support and feedback.					
Process engineering	1.3	5.6	22.3	49.8	21.0
Power engineering and building systems	3.1	11.7	18.4	46.6	20.2
Total	1.9	7.7	20.9	48.7	20.7
One is shown by professionals how a problem ought to be addressed.					
Process engineering	0.6	3.9	23.5	59.4	12.6
Power engineering and building systems	3.7	6.1	23.3	56.4	10.4
Total	1.7	4.7	23.5	58.4	11.8

Table 6.6 Trainees' views concerning the training practitioners in the company

	Very rarely (%)	Rarely (%)	Sometimes (%)	Often (%)	Very often (%)
The professionals explain the reasoning they use when working on a problem in their area.					
Process engineering	1.9	9.7	39.9	42.5	5.8
Power engineering and building systems	4.3	12.3	40.1	38.9	4.3
Total	2.8	10.6	40.0	41.3	5.3

above all when the learners are challenged in the processing of work assignments and when there is the opportunity to draw on the support of professionals. In a modern VET programme this support is provided not only by the trainers, but also (in the sense of the 'learning enterprise') by the other skilled workers.

The following tables show to what extent, from the trainees' point of view, the experts in the company support the trainees in the acquisition of the knowledge and skills necessary for the processing of professional work tasks (Table 6.5).

Only a minority (15% in process engineering, 7% in power engineering) has the impression that the support in the processing of work assignments is insufficient. This suggests that trainers and skilled workers together make sure that the trainees receive enough support to learn successfully in the work process.

The skilled workers are regarded as experts in their domain by two thirds of the trainees. However, it also becomes clear that the skilled workers who take part in the training are not always able to explain their intellectual operations that accompany the work process. Only half of the trainees think that these explanations are successful (Table 6.6).

Company-based learning is most successful when trainees are confronted with work tasks that challenge their potential for development. Training in the enterprise should also allow trainees to contribute their own knowledge and skills. This is the way learning takes place. However, the results of the I:BB studies on the costs, benefits and quality of training in enterprises (cf. Maurer et al. 2009) have shown

Table 6.7 Trainees' estimate of the level of work tasks

	Very rarely (%)	Rarely (%)	Sometimes (%)	Often (%)	Very often (%)
The work tasks are too easy.					
Process engineering	1.6	22.1	54.1	15.6	6.6
Power engineering and building systems	5.1	32.2	50.8	10.2	1.7
Total	3.3	27.1	52.5	12.9	4.2
The task I have to work on is a challenge for me.					
Process engineering	4.3	21.1	52.6	19.4	2.6
Power engineering and building systems	5.6	20.0	51.9	20.0	2.5
Total	4.7	20.7	52.4	19.6	2.6
My work tasks are as demanding as those of skilled workers.					
Process engineering	5.0	21.0	41.2	23.5	9.2
Power engineering and building systems	2.6	12.8	35.0	35.0	14.5
Total	3.8	16.9	38.1	29.2	11.9

Table 6.8 Trainees' estimate of the opportunity to apply newly acquired knowledge and skills

	Very rarely (%)	Rarely (%)	Sometimes (%)	Often (%)	Very often (%)
I have the opportunity to show what I have learned in the relevant area of expertise.					
Process engineering	2.9	10.1	26.5	45.1	15.4
Power engineering and building systems	5.6	4.3	29.2	47.8	13.0
Total	3.9	8.1	27.4	46.0	14.6

that the learning potentials of in-company training are often not fully exploited. What do the trainees themselves think about that?

The trainees' opinion concerning the *level* of the training was surveyed with statements like 'The tasks are too easy', 'The task I have to work on is a challenge for me' and 'My work tasks are as demanding as those of skilled workers' (Table 6.7).

In the industry the level is rated rather low by the trainees. Almost every fourth trainee indicates that often or very often the work tasks are too easy, or that they are seldom a challenge. This is clear evidence that in these cases the learning potentials in the company are not fully exploited. Moreover, only one third holds the view that the work assignments they have to work on have the same level of sophistication as the tasks of skilled workers. In the crafts, by contrast, every second trainee indicates that the requirements of the work tasks are often equivalent to the level of skilled workers.

The acquisition of professional competences and skills requires also opportunities and *room for maneuver* where the trainees can apply their newly acquired knowledge and skills in the professional practice (Table 6.8).

Table 6.9 Trainees' estimate of the complexity of work tasks

	I strongly disagree (%)	I disagree (%)	I agree (%)	I strongly agree (%)
The training allows me to do different things and to use different forms of knowledge and skills.				
Process engineering	2.9	22.5	37.5	37.1
Power engineering and building systems	5.0	19.9	36.0	39.1
Total	3.6	21.6	37.0	37.8

Table 6.10 Trainees' views about the scope of tasks as a representation of the occupational profile

	I strongly disagree (%)	I disagree (%)	I agree (%)	I strongly agree (%)
My work assignments cover the entire occupational profile.				
Process engineering	3.3	19.7	44.3	32.8
Power engineering and building systems	6.7	25.8	40.8	26.7
Total	5.0	22.7	42.6	29.8

Approximately 60% of the trainees indicate that often or very often they have the opportunity to use their newly acquired knowledge and skills in the operations of the enterprise. However, a minority of 12% in the process engineering programme says that they have this opportunity seldom or not at all.

In order to attain the main objective of vocational education – professional competence – it is necessary to give the trainees professional work tasks that are characterized by variety and increasing complexity and which represent the occupational profile as fully as possible. These requirements are met in both occupations to a large extent. However, the trainees' responses also indicate that there is still some potential for improvement (Table 6.9).

While three quarters of the trainees hold the view that in the course of their training process they become acquainted with different areas of work and have the opportunity to use different forms of knowledge and skills, one third of them feel that the scope of tasks is rather narrow. In power engineering the proportion of complex assignments is estimated high by more than half of the trainees. In process engineering, on the other hand, this is only occasionally the case.

At the end of the section concerning the quality of in-company work tasks the trainees were asked to what extent, in their view, the assignments were representative of the occupational profile (Table 6.10).

Especially the trainees in process engineering are of the opinion that the contents of the company-based training, i.e. the work assignments, largely cover the entire occupational profile. This statement is affirmed by a total of more than three quarters of the respondents. The trainees in power engineering and building systems have a more skeptical attitude – one third of the respondents think that the work tasks reflect the occupational profile only to a limited extent. This may be due to the fact

Table 6.11 Relevance of trainees' work for the training enterprise

	I totally disagree (%)	I disagree (%)	I agree (%)	I strongly agree (%)
I am entrusted with tasks and problems that are also relevant for the enterprise as a whole.				
Process engineering	6.9	31.5	47.9	13.8
Power engineering and building systems	7.5	29.4	46.9	16.3
Total	7.1	30.8	47.5	14.6
Other employees depend on the results of my activities.				
Process engineering	12.2	40.1	37.8	9.9
Power engineering and building systems	7.5	35.6	38.8	18.1
Total	10.6	38.6	38.1	12.7
Responsible tasks are assigned to me.				
Process engineering	5.2	34.8	42.3	17.7
Power engineering and building systems	3.8	24.5	52.2	19.5
Total	4.7	31.1	45.7	18.3

that the work assignments in this occupation are closely linked to real, company-specific customer orders so that parts of the occupational profile may be paid less attention in the work routine of the training enterprise.

Concerning the relevance of their work tasks and activities two thirds of the trainees – irrespective of the occupation – are of the opinion that what they do really matters to the company and that a sense of responsibility for their work is expected from them. More than half of the trainees in the power engineering programme also think that other workers in the company depend on their output, which suggests that the trainees are regarded as colleagues of equal status (Table 6.11).

6.4 Characteristics of the Vocational School

The notion of the dual system of vocational education and training implies that the two learning venues – the training enterprise and the vocational school – have equal status and cooperate closely with a view to high-quality training. Despite legislative reforms in recent years the implementation of this model in Germany is still insufficient, and the two learning venues are still far from a truly equal status. For instance, the achievements of trainees in the vocational school still have little relevance for the successful completion of the training programme. Nor are these school attainments documented in the vocational certificate.

Moreover, it appears that in spite of 30 years of innovative pilot projects in the field of cooperative training there has been only little progress in bringing together the 'two worlds' in a way that could be fruitful from the trainees' point of view.

Table 6.12 Trainees' satisfaction with their own performance in the vocational school

	I strongly disagree (%)	I rather disagree (%)	Undecided (%)	I rather agree (%)	I strongly agree (%)
I am quite satisfied with my performance in the vocational school.					
Process engineering	5.8	17.3	34.4	31.6	10.9
Power engineering and building systems	8.3	25.0	37.2	23.7	5.8
Total	6.7	20.0	35.3	28.9	9.1

Table 6.13 Trainees' views about the relevance of the vocational school

	I totally agree (%)	I rather agree (%)	I rather disagree (%)	I totally disagree (%)
In our school the lessons are frequently disturbed by students.				
Process engineering	20.8	41.6	29.9	7.7
Power engineering and building systems	34.4	33.1	26.1	6.4
Total	25.5	38.7	28.6	7.3
In our school some students are absent in some of the lessons.				
Process engineering	10.1	23.3	34.1	32.4
Power engineering and building systems	31.8	37.7	20.8	9.7
Total	17.6	28.2	29.6	24.7

Given this background we were particularly interested in the trainees' opinions on the following issues: How important is the vocational school in the context of the training programme? How do trainees regard the teachers' attitude as well as their own? How well do schools and enterprises cooperate, and to what extent do trainees succeed in connecting the contents learned in the school and in the enterprise?

On the whole the trainees are quite ambivalent with regard to their own performance in the vocational school. While the trainees in process engineering are relatively satisfied with their performance, the majority of power engineering trainees is reluctant to take sides (Table 6.12).

The relevance of the vocational school from the perspective of the trainees can be inferred from the extent to which school lessons are followed attentively and attended regularly (Table 6.13).

Over 60% of the trainees hold the view that lessons are frequently disturbed by students. One third of the process engineering trainees indicate that classmates stay away from single lessons. In the programme for power engineering it is more than two thirds of the respondents who agree with this statement. This is a clear indicator that the vocational school is regarded by many trainees as secondary to the training enterprise.

As regards the commitment of teaching staff and their awareness of the situation in the enterprise, the views of the trainees are ambivalent. On average half of the

Table 6.14 Trainees' views concerning teaching staff in the vocational school

	I totally agree (%)	I rather agree (%)	I rather disagree (%)	I totally disagree (%)
The teachers take care of individual students.				
Process engineering	8.7	42.8	34.4	14.0
Power engineering and building systems	17.2	42.7	31.2	8.9
Total	11.6	42.8	33.3	12.3
The teachers have good knowledge of the reality in the enterprise.				
Process engineering	10.0	37.1	37.1	15.7
Power engineering and building systems	12.2	38.5	30.0	18.6
Total	10.8	37.6	34.9	16.7

Table 6.15 Trainees' views about the quality of the cooperation between school and enterprise

	Good (%)	Rather good (%)	Rather bad (%)	Bad (%)
Cooperation between school and enterprise				
Process engineering	8.0	35.7	45.2	11.1
Power engineering and building systems	1.2	16.6	60.7	21.5
Total	5.7	29.1	50.5	14.7

respondents confirm that teachers have a good knowledge of the reality in the enterprise and that they show commitment also with regard to individual problems (Table 6.14).

Finally we were interested in the trainees' views about the quality of the cooperation between the training enterprise and the vocational school, the relevants of teaching contents for the occupation, and the extent to which school instruction contributes to the successful exercise of work tasks in the enterprise. These items form a scale to measure the quality of cooperation between school and enterprise (Tables 6.15, 6.16).

The aim of a closer cooperation of the learning venues is above all to coordinate the contents of teaching and training in such a way that their connection becomes clear to the trainee. However, more than half of the trainees in process engineering and more than 80% of the trainees in power engineering think that the cooperation of the school and the enterprise does not work very well. About 40% of the process engineering trainees hold the view that school instruction is of little or no use for the practice of work. Among the trainees in power engineering the responses to the question as to how much school instruction helps them to perform their work tasks in the company are also quite negative. It is only one out of four trainees who thinks that the contents taught at school are useful for in-company training.

This evaluation by the trainees varies depending on the quality of cooperation between the learning venues. This is to say that for those trainees who give the

Table 6.16 Trainees' views about the relevance of school instruction

	I totally disagree (%)	I rather disagree (%)	Undecided (%)	I rather agree (%)	I totally agree (%)
The instruction in the vocational school helps me to solve tasks and problems in my work in the company.					
Process engineering	15.5	24.6	37.4	17.5	5.1
Power engineering and building systems	10.3	28.8	32.1	25.4	3.2
Total	13.7	26.0	35.5	20.3	4.4

Table 6.17 Correlation between the quality of cooperation between learning venues and the relevance of school instruction for the occupation

	I totally disagree (%)	I rather disagree (%)	Undecided (%)	I rather agree (%)	I totally agree (%)
The contents taught at the vocational school are important for my occupation.					
Good rating of the cooperation of learning venues	2.6	7.3	24.4	42.7	23.1
Bad rating of the cooperation of learning venues	6.8	14.1	27.7	39.5	11.8
Total	4.6	10.6	26.0	41.2	17.6

cooperation between their training enterprise and the vocational school a better rating the school lessons are significantly more helpful in the fulfillment of work tasks in the company (Table 6.17).

The correlation between the quality of cooperation between the learning venues and the relevance of instruction in the vocational school is not confined to the application of school-based knowledge in concrete work situations. It is also the case that trainees who give the cooperation a good rating tend to regard the contents of school instruction as generally more important for the occupation than do those whose evaluation of the cooperation is negative. This points out that the cooperation of the learning venues is an important factor for the development of professional identity.

References

Bundesministerium für Bildung und Forschung (BMBF). (2008). *Berufsbildungsbericht 2008*. Berlin.

Deutsches PISA-Konsortium. (Hg.). (2005). *PISA 2003. Der Bildungsstand der Jugendlichen in Deutschland – Ergebnisse des zweiten internationalen Vergleichs*. Münster: Waxmann.

Maurer, A., Rauner, F., & Piening, D. (2009). *Lernen im Arbeitsprozess – ein nicht ausgeschöpftes Potenzial dualer Berufsausbildung* (A+B-Forschungsbericht Nr. 4). Bremen: A+B Forschungsnetzwerk.

Chapter 7
Results 2008: Apprentices Competence

7.1 Overview of Competence Levels: Can the PISA Forecast About the Trainability of At-Risk Students Be Confirmed?

Not all at-risk students become at-risk trainees. Vocational education appears to have some potential for compensation. More than one third of the students at risk turn out to be trainable, if only at a low competence level.

In the debates about a VET PISA the fact is often neglected that already the first PISA report (2002) discussed in great detail the transition from school to work and the related issue of the trainability of 15-year-olds.

Students who attained only the first competence level in the PISA project are defined as students at risk. In terms of scientific literacy this is the level of nominal competence. According to the PISA definition, at-risk students do not meet the requirements for a successful vocational education and training programme and therefore have to expect considerable difficulties in the transition to work (Baumert et al. 2001, 117).[1] In the PISA 2000 and PISA 2003 studies the dimensions of the at-risk group in Germany were as follows:

- 22.6% (PISA 2000)/22.3% (PISA 2003) in reading
- 24.0%/21.6% in mathematics
- 26.3%/23.3% in scientific literacy.

When these results are broken down at the *Länder* level, considerable differences become visible. We concentrate here on the figures for scientific literacy because it can be assumed that there are some similarities between industrial-technical training and science education. In the two *Länder* taking part in the COMET project the proportion of at-risk students in the field of scientific literacy was 38.1% (2000) and 30.8% (2003) in Bremen and 30.9 and 26.7% in Hessen.

[1] Henceforth cited as "PISA 2000".

F. Rauner et al., *Competence Development and Assessment in TVET (COMET)*, Technical and Vocational Education and Training: Issues, Concerns and Prospects 16,
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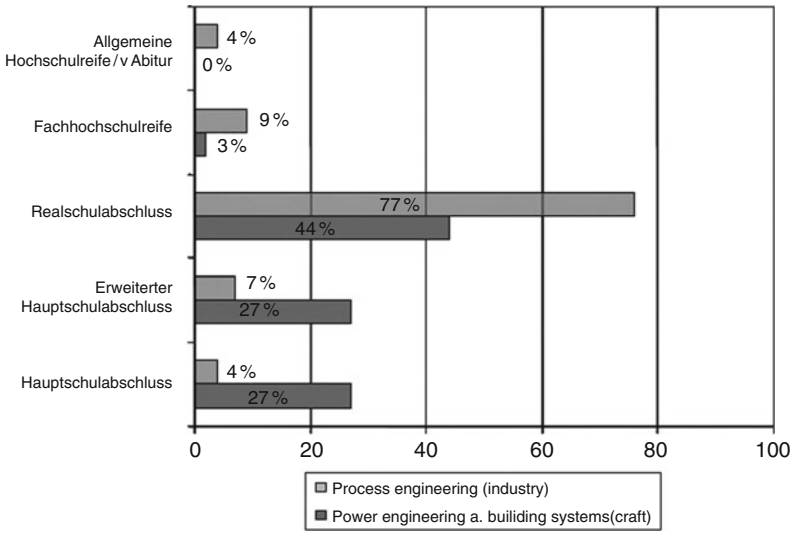

Fig. 7.1 Prior school attainments of the trainees in Hessen

Concerning the analysis and interpretation of the COMET data it makes sense to use the PISA data for comparison because this makes it possible to investigate whether at-risk students actually fail in vocational education, which is an expectation suggested by the PISA definition of at-risk groups. When the PISA results on the at-risk groups are broken down by prior school attainments, we find that the high numbers of at-risk students for the city-states can above all be attributed to people who attend the *Hauptschule*. In Bremen the figure is almost 100% (PISA 2000). This means that *Hauptschule* attendants in Bremen are almost always at-risk students. In Hessen this value was also considerably high, being 75% (PISA 2000). For the COMET project this means that the interpretation of test results has to take into account particularly the composition of the test groups in terms of prior school attainments (Figs. 7.1, 7.2).

On this basis it can be estimated how big the proportion of at-risk students in the test groups of the COMET project should be. If the hypothesis from the PISA study is correct that at-risk students turn into at-risk trainees, then the figures for the proportion of test persons who reach only the level of nominal competence can be expected to be quite similar for COMET and the PISA test of scientific literacy. It is also necessary to draw a distinction between high-performing and low-performing students. The trainees in the occupation of electronics technician for power engineering and building systems are predominantly low-performing students. Their achievements in mathematics, German and English are characterized by lower average marks than those of the trainees in process engineering. For Bremen it can be assumed that approximately 80% of the trainees in power engineering and building systems are at-risk students according to the results of PISA 2000 and 2003

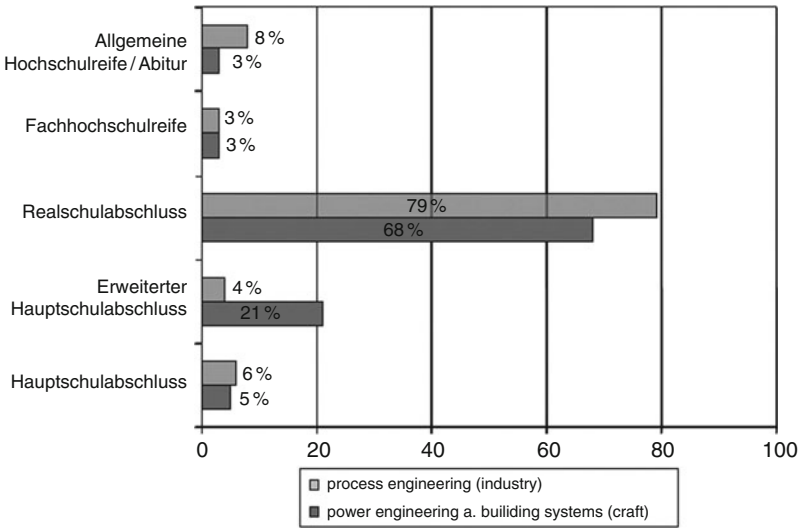

Fig. 7.2 Prior school attainments of the trainees in Bremen

(scientific literacy). In Hessen this share is supposed to be about 60%. As regards the trainees in process engineering, the higher proportion of trainees with a medium-level school qualification and the small proportions of attendants of the *Hauptschule* or the *Gymnasium* is comparable to the PISA test group. Taking the two occupations together, the proportion of at-risk students can be estimated at 40% in Hessen and 60% in Bremen.

The distribution of test persons ($N=627$) across the four competence levels displays some particular characteristics. What is striking at first sight is that the distribution is quite similar to the one in the scientific literacy test (PISA 2000). The PISA definition concerning at-risk students is confirmed by this distribution, as is the weak representation of the two upper competence levels (Fig. 7.3).

When the results are broken down by *Länder* and by occupations, the image with regard to vocational education is much more positive.

The proportion of at-risk trainees in Bremen is 42% and thus considerably lower than the expected value of 60%. In Hessen the ratio, being 25% (COMET) to 40% (expected), is even better. When the training occupations are compared, the expectation is confirmed that vocational education is capable of compensating, to some extent, the competence deficits of at-risk students. In the power engineering programme the proportion of trainees who attain only the level of nominal competence is 50% in Bremen and 47% in Hessen, which is considerably below the expected figures of 80 and 60% respectively (Fig. 7.4).

Of course the test result is problematic with regard to the objectives and guiding principles of vocational education and training. Only half of the trainees in the crafts sector reach one of the levels of professional competence. The proportion of those

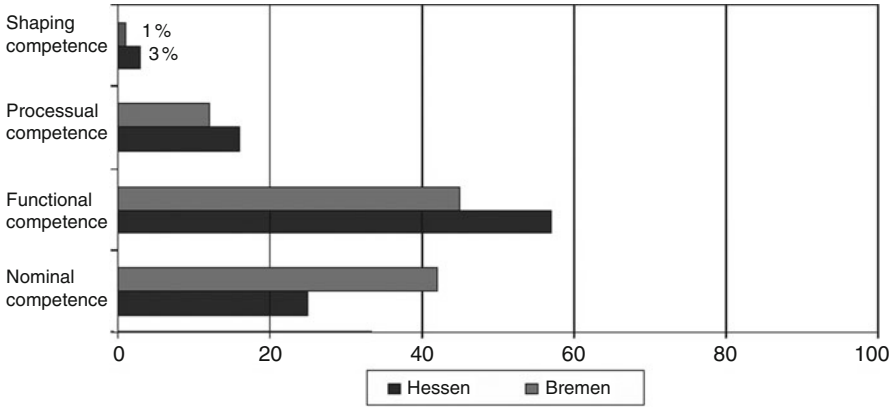

Fig. 7.3 Distribution of competence levels (comparison of Hessen and Bremen)

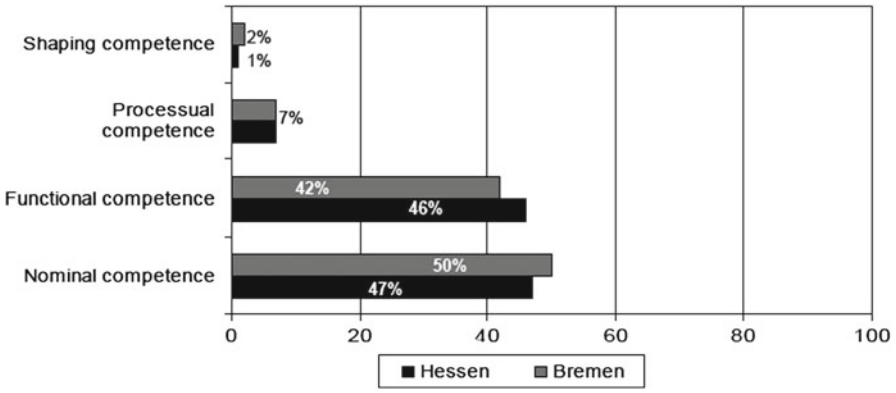

Fig. 7.4 Distribution of competence levels in the training programme in power engineering and building systems

who attain the level of shaping competence is extremely small, which is alarming in some sense because it shows that the fundamental paradigm shift towards a vocational education that enables trainees to participate in shaping the world of work and the wider society obviously did not make its way into this particular occupation.

The larger share of trainees with higher general education in the process engineering programme leads to a much better picture with regard to the distribution across competence levels. The at-risk group is only 15% in Hessen and 30% in Bremen instead of the 38% that were to be expected on the basis of the scientific literacy test (PISA 2000, 2003). For Hessen the share of at-risk students has been reduced to a half compared to the expected value. Almost one fifth of the trainees arrive at the level of processual competence. Here the score for the highest competence level is also extremely low. A comparison with the distribution across the levels of

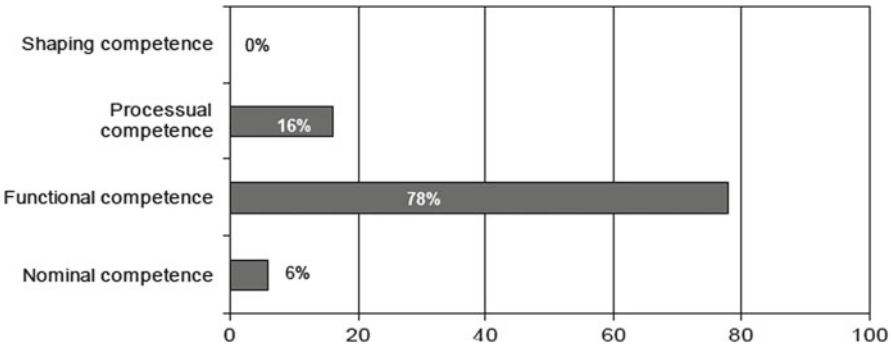

Fig. 7.5 Distribution of competence levels in the training programme in process engineering

scientific literacy shows that the figures are quite similar. In the COMET study, the smaller proportion of at-risk trainees is represented by a higher share of those at the level of functional competence (Fig. 7.5).

The analysis of the COMET data at the level of school classes confirms the overall result. However, some examples show that it is possible to reduce the proportion of at-risk trainees to less than 5%. These examples are an encouragement to strengthen the compensatory potential of vocational education by means of a stronger diversification in dealing with the heterogeneity of trainees. This is a challenge for both learning venues, especially when the realization of a workable cooperation between the institutions is at stake.

Conclusion: The COMET results about the trainees' competence levels confirm in part the prognosis of the PISA study on scientific literacy (2000). At-risk students become at-risk trainees, albeit not to the extent that was predicted. The smaller proportion of at-risk trainees can be attributed, with the necessary reservation that this is still a preliminary result, to the compensatory effect of vocational education and training. The detailed analysis of the data delivers some information about how far vocational education succeeds in compensating the deficits in general education. The aggregated results on the distribution of trainees across the competence levels show that the learning venues, which are supposed to observe a division of labor where the vocational school is responsible for the theoretical knowledge while the training enterprise has to impart the professional skills, live up to their roles with unequal success. The theoretical knowledge or functional competence, being a fundamental type of professional knowledge, is transferred quite successfully. The vocational school thus accomplishes its traditional mission and manages to fulfill, to a limited extent, its compensatory function.

When the contribution of the vocational school to the development of professional competence is evaluated against the principles and objectives associated with the concept of learning areas, the interpretation of the test results changes. According to this evaluation there has been hardly any success in implementing the concept of learning areas. In the course of the training process no concept of professional work

was imparted that extended beyond the level of functional competence. Apparently the strategies adopted for the implementation of the concept of learning areas are insufficient with regard to the comprehensive development of professional competence in the sense of the competence model. This shows that the COMET methodology is also an effective instrument for the design and self-evaluation of teaching and training.

The training enterprise as a learning venue is characterized by learning in the work process. Vocational – and not just subject-related – learning is based on reflective work experience, which is the basis for the impartation of a concept of professional work and learning. This is expressed in particular by process and shaping oriented competences. The relatively small proportion of trainees who reach the competence levels II and III can accordingly be regarded as an indicator for the fact that company-based training has some difficulty to support the integration into the profession in accordance with the guiding principles for training in enterprises. Once again the exception proves the rule. The implementation of the concept of learning areas and the attainment of higher competence levels can obviously be supported by a better coordination of school-based learning and company-based learning.

The pedagogical concept of so-called situations of learning is regarded by practitioners as a strategy for the implementation of the concept of learning areas. Learning areas and learning situations are instruments of a practice of school instruction that is institutionally detached from the training enterprise and the work process. Accordingly the pedagogical activities are confined to the (narrow) limits of school-based learning.

The competence profiles show which aspects of competence were developed to what extent in the course of the training, and what aspects are still in need of development.

For all trainees of the two training occupations there are average competence profiles that characterize the majority of trainees. The differences between individuals are constituted by the strength of the single competence components and not so much by the competence profile.

The technical and instrumental skills and the ability to explain and present the technical aspects of the solution are approximately twice as strong as the competences related to work and business processes. In the planning and conceptualization of a solution the technical knowledge obviously dominates. On the other hand, the ability to carry out a customer's order in a competent manner as described in the occupational profile – an ability that is at the heart of professional competence – is developed to a much lower level. When the COMET results are compared with the occupational profiles one finds that the reality of the training process is turning these priorities upside down. The competence that is most relevant according to the profile ("electronics technicians always pay attention to all safety aspects and make sure that solutions are also optimal in terms of economy and ecology, […] they advise their customers about technical variants, service and costs […] and familiarize the customers with the company") reaches only scores of 6.6 for processual competence and 5.5 for shaping competence. This level is below the

threshold above which it would be justified to regard this competence distinction as sufficiently realized. The stagnation of the competence development between the second and the third training year is also visible in the competence profile. The realization of the three competence levels remains unchanged. When there is no competence development from the second to the third year of training, then there is above all a lack of reflected work experience in the relevant areas of learning. A stagnation like this is only possible when learning in the workplace is reduced to the fulfillment of routine tasks.

7.2 No Competence Gaps Between Second- and Third-Year Trainees

Dual vocational education and training is particularly influenced by the two examination dates in the middle and at the end of the training period. During the "interim periods" where no assessment takes place there is a stagnation of competence development. This could be counteracted by an assessment practice that is extended over the entire training period and administered by both learning venues.

The COMET methodology allows to investigate the competence development from the second to the third year of training in the course of a longitudinal study. In anticipation of this study second- and third-year trainees were already included at the time of the first test (pilot phase). The participants from the second year were trainees who had just taken the first part of the "extended examination". In the case of the third-year trainees this part of the examination lay already 10 months behind and the final examination was still 8–9 months ahead. Prior to the survey teachers occasionally pointed to the phenomenon of a so-called "adjourned game", suggesting that trainees, having taken the first part of the examination, would now "rest on their laurels" for some time (laurel effect).

When the results for the two test groups (second and third training year) are compared it becomes obvious that there is no significant difference in the competence levels. The "laurel effect" is confirmed so far. It has to be assumed that the trainees acquire new knowledge and skills in the course of 1 year as expected by the curricula and training regulations. This knowledge acquisition could easily be measured by the established methods of performance assessment. However, when the competence levels in the sense of cognitive dispositions for professional activity are measured, then the surprising result is that there is no difference between the second and the third year of training. This result is also confirmed when the data are broken down by occupations or school locations (Fig. 7.6).

For all test groups, irrespective of the characteristics according to which they are defined, the result is the same. There is no competence gap between the trainees from the second and the third year of training (what does not exclude possible learning and development of skills). Obviously this is a relatively stable phenomenon. As said above, a possible explanation is the lack of reflected work experience in the relevant areas of learning.

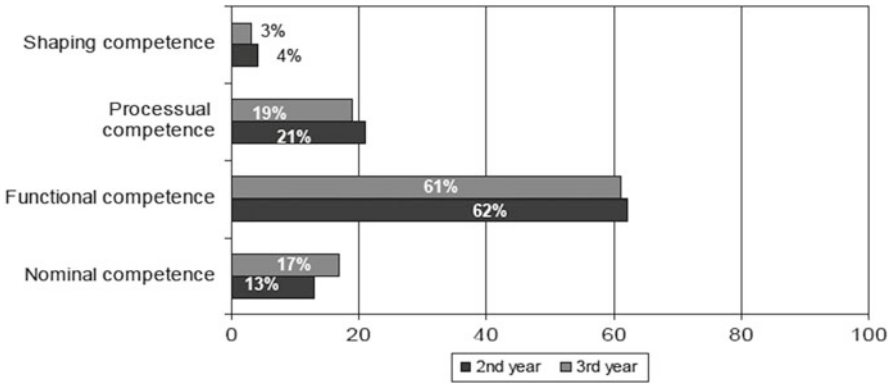

Fig. 7.6 Comparison of the competence profiles of second- and third-year trainees (electronics technicians for process engineering, Hessen)

The result cannot be attributed to the form and content of the test assignments because the assignments clearly distinguish between individuals and test groups. It has to be supposed that the causes for this test result are rooted in the structure of the training process. If this is the case, then it must be a characteristic of dual vocational education and training that can neither be influenced by the teachers and trainers nor by the specific contexts at the different locations. The structure of the training process is determined by the organization of examinations. The introduction of the so-called extended examination has considerably increased the importance of the intermediate examination, which is now the first part of the final examination.

The replacement of the intermediate examination by the model of the extended examination makes the preparation for the two parts of the assessment particularly relevant and leads to a profound change of the training structure. In the course of a project on the evaluation of the cost-benefit ratio of company-based training with more than 200 training enterprises information was collected about the time amount required for the preparation. The findings suggest that since the establishment of the extended examination trainees are prepared for the tests by their teachers and trainers during the weeks before the first and the second part of the examination. This punctual intensification of learning efforts is a possible explanation for the "downer thesis" put forward by some of the teachers. According to this thesis the motivation of trainees declines after the first part of the examination and recovers only during the preparation for the second part. This effect was confirmed with the help of the large-scale competence diagnostics of the COMET project.

The performance assessment in the vocational school and its results have little or no effect in this context. These tests of learning achievements are carried out regularly and may in principle contribute to a continuous motivation of the learners. However, given that the assessment in the vocational school is not part of the examination procedure and given that the vocational school is not responsible for carrying out parts of the examination, there is currently no opportunity for the schools to support

the trainees' competence development by means of an evaluation and assessment practice along the training process. The hypothesis that this is as great a disadvantage for competence development as the established punctual, short-term assessment practice is investigated further in the course of the COMET project.

Conclusion: It is only with the methodology of a large-scale competence diagnostics on the basis of a pedagogically sound and psychometrically tested competence model that it becomes possible to analyze the relationship between the practice of vocational education – including examinations – and the development of professional competence. The test results of the pilot phase show that in the 1-year interval after the first part of the examination within a three-and-a-half-year training programme there is no growth in competence. During the further implementation of the project the hypothesis will be investigated that the punctual examination in two parts after 18 months (part 1) and towards the end of the training period after 40 months (part 2), which leads to a period without any assessment of more than 20 months, is a crucial explanatory factor for the stagnation of competence development between the second and third year of training. The investigation of this hypothesis is important for the development of assessment schemes. In the event that the "downer thesis" is confirmed the consequence would be to develop the concept of extended examination into a model of continuous evaluation and assessment along the training, which would replace the existing punctual examinations the establishment of a feedback culture. Another consequence would be the involvement of the vocational school in this practice of permanent assessment. For this reason a third test date towards the end of the training period is provided for in the COMET project. If the downer hypothesis is confirmed, a significantly higher competence level than at the first two dates will have to be expected at the third test date.

7.3 Pronounced Heterogeneity Between High-Performing and Low-Performing Trainees

The vocational school is challenged by the heterogeneity of its students more than any other type of school. Dealing with this heterogeneity requires new forms of differentiated and individual support of the students/trainees. This calls for the introduction of new forms of teaching and learning.

The differences and the dispersion of competence scores between test persons and test groups, which are selected according to various criteria like occupation, age, prior learning etc., give information about the degree of heterogeneity to be expected in vocational education and training. An appropriate means for the visualization of this heterogeneity are the percentile bands developed in the PISA studies.

The visualization by percentile bands makes it possible to give a clear presentation of three different characteristics of the various groups. First, the marking in the centre shows the mean of the group. By comparing the means of the different groups it becomes possible to identify differences with regard to the average performance (Fig. 7.7).

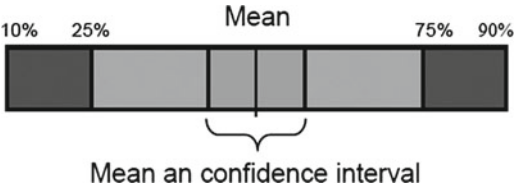

Fig. 7.7 Example of a percentile band

Second, whether or not these differences are significant is expressed by the highlighted parts of the percentile bands, the confidence intervals. With a probability of 95% the 'true' mean, i.e. the average that can be inferred from the sample for the entire population, lies within this interval. This means that differences between two groups are significant and most likely not due to random when the two intervals do not overlap.

The third important aspect covered by the percentile bands is the dispersion of the results, i.e. the distance between better and worse test scores. The lighter parts of the bands represent the scores for 25–50% and 50–75% of a group. This range includes the scores of those 50% of the trainees who are grouped around the mean. The darker parts include the cases that constitute the lower (10–25%) and upper ends (75–90%) of the scale. The best and the worst 10% of the test scores are not included in order to avoid distortion by freak values. To summaries: The lighter parts of the percentile bands represent the range in which the middle-ranking 50% of the test scores are located. The band as a whole represents the scores of 80% of the participants. The best and the worst 10% of the test results are not represented.

In the PISA study it proved to be useful to translate competence differences between groups into approximate development phases (school years). A rule of thumb was formulated according to which differences of about 40 points are interpreted as a difference of one school year (PISA-Konsortium Deutschland 2005, 38). In the context of the COMET project it can be assumed that there is a difference of about 50–60 points between a novice and a top expert. This is equivalent to the amount of time required for a complete vocational education and training programme. According to the PISA rule of thumb, one training year thus has a value of about 15 points.

The heterogeneity of the trainees' achievements is a challenge for the vocational school if this heterogeneity exists not only at the level of the test population, but also at the levels classes.

This is precisely what is shown in Fig. 7.8: There is a slightly difference between the learning groups in terms of average performance, and the variation of the performance scores is very high.

The distances between the best 10% and the worst 10% of trainees are extremely high, the dispersion being around 30 points at most of learning groups. This competence gap is almost equivalent to 2 years of training. The low-performing trainees did not raise above the level of beginners in most of the classes. In two out of seven classes the competence of trainees varies by 18–19 points. This is more than 1 year of training.

When all trainees are ranked by their scores and allocated to the corresponding qualification levels, statistical limits for the qualification levels can be identified.

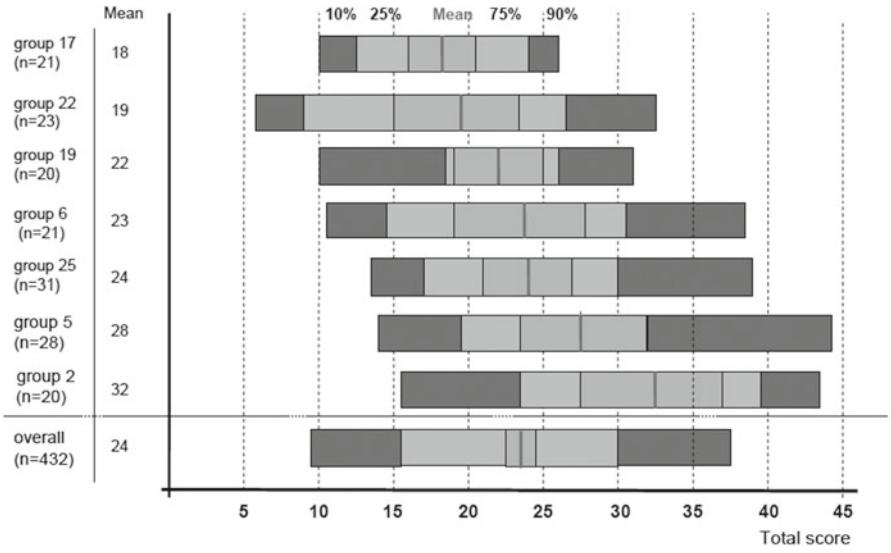

Fig. 7.8 Distribution of professional competence scores by vocational classes

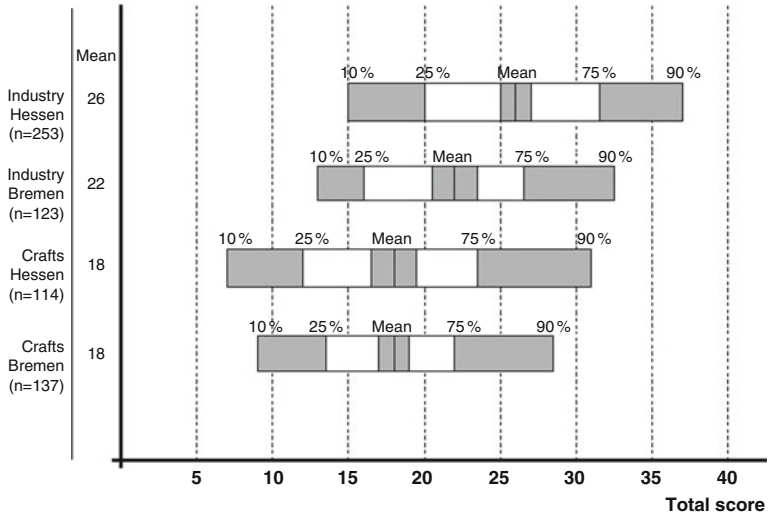

Fig. 7.9 Distribution of competence scores by occupations

The heterogeneity in terms of professional competence depends only to a small extent on the differences between the two occupations. Figure 7.9 shows that trainees within one and the same occupation also differ in their professional competence in a way that is equivalent to 1 or 2 years of training. This is true for both test locations, Hessen as well as Bremen.

Conclusion: The differences with regard to professional competence within one training occupation in one and the same training year are enormous. The high degree of heterogeneity is an additional obstacle for the successful implementation of the concept of learning areas in the vocational school. The vocational school is challenged by the heterogeneity of its target group more than any other type of school. Dealing with this disparity requires new forms of differentiated, individual support of the trainees/students. What is necessary is the introduction of new forms of teaching and learning as well as a competence diagnostics that makes it possible to identify the needs for individual assistance.

7.4 Findings About the Individual Support of Trainees

The COMET model allows for a presentation of individual test results that takes into account the aspects of quantification on the one hand and visualization of the quality of competences on the other. The latter is done by means of a competence profile composed of eight competence components and three competence levels. The spider diagram is a particularly useful tool for this purpose.

This test also showed that the participants have a substantial interest in their own results. The question "How did I score?" expresses a fundamental interest in one's own performance, which can be inferred easier from a school mark or a point score than from a criterion-based representation of test results.

It has to be observed in the interpretation of the spider diagrams that the points representing the values for the eight competence criteria are connected so that they describe a figure whereas the competence criteria actually represent aspects of competence that are independent of each other. This type of presentation is justified only if these figures are regarded as a means of visualization and not as a geometrical representation in the strict sense. Another distorting effect results from the fact that the figures are used as a square value for the presentation of one-dimensional values. Accordingly the area is not a measure of competence.

However, the experience with using spider diagrams shows that users quickly learn to interpret the values realistically. This effect is supported by the fact that the arrows representing the competence levels are not connected and do not constitute a figure so that the length of the arrows accurately represents the competence distinction. This way of presenting the competence profiles in diagrams was developed with a view to the individual counseling of trainees. In all cases the teachers supported the trainees in the interpretation of their own competence diagrams. The analysis of results for the purpose of individual guidance was always based on the explicit consent of the trainee, and individual results were made known only to the trainee and the responsible teacher.

The following figure shows the competence profiles of four classmates whose test results are extremely different. The spider diagram A is related to a person from the 90% percentile while the profile D belongs to the 10% percentile. The competence profiles of the trainees in this class are located evenly between these two. The high diagnostic value of the diagrams is rooted in the following aspects (Fig. 7.10).

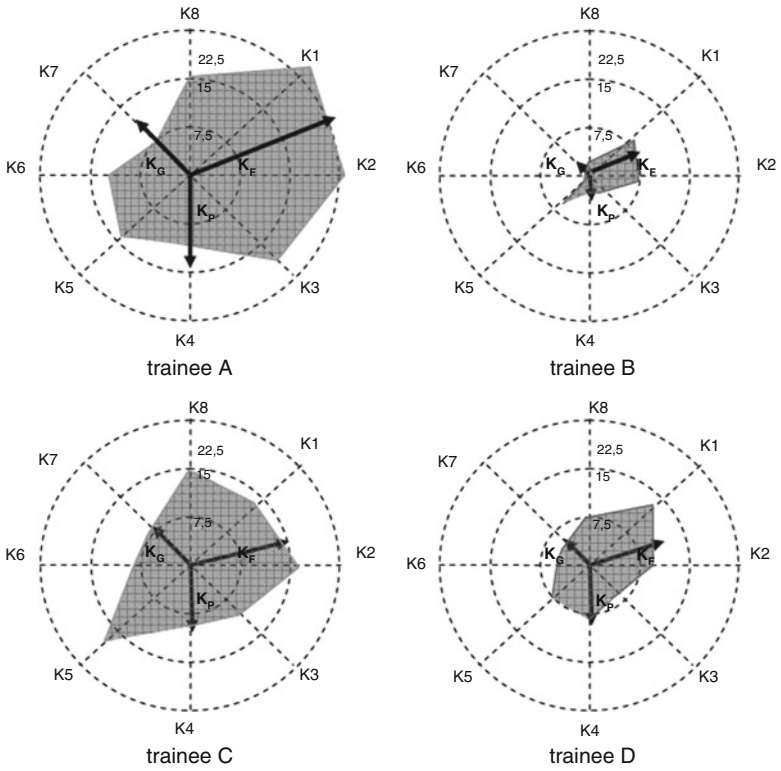

Fig. 7.10 Competence profiles of four trainees from one vocational class

1. The teacher is informed about the quantitative and qualitative extent of disparity in the trainees' competence development. Trainee A has a high level of professional competence, enabling him to understand, structure and solve professional tasks in their full complexity. At the same time the trainee can see the components of professional competence that still need to be developed further. In this case it is obvious the subjective opportunities for professional development in the learning processes at both learning venues are good. In the cases of test persons C and D the professional competence is low. What is remarkable in D is that a certain functional competence is visible while the values for the other components are negligible. Quite probably the competence development of this trainee can be supported only by improving the cooperation between the school and the training enterprise, and by organizing the work assignments in the enterprise so as to integrate them into the business process.
2. The competence profiles of the trainees reflect the ways the trainees organize and process their work assignments. It is immediately visible which aspects of professional competence were developed to a greater or lesser extent through the form of processing. The variation of the competence components between the

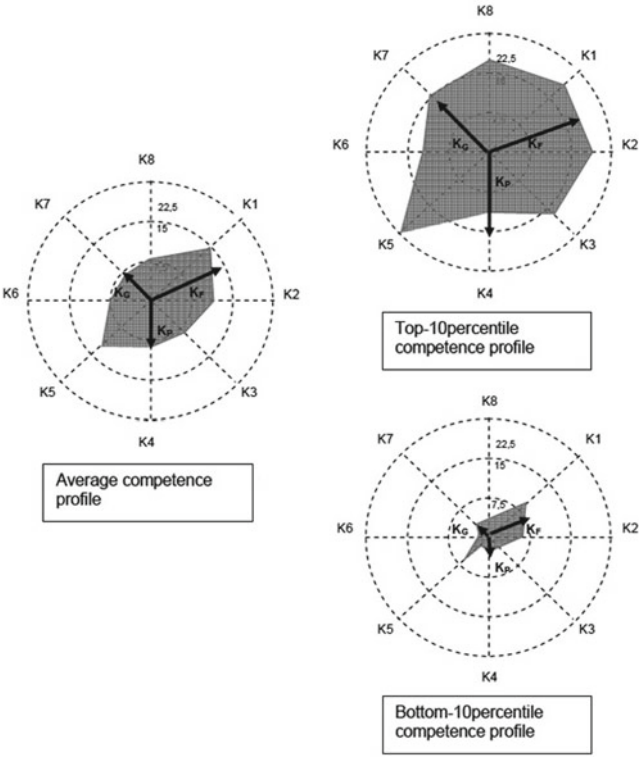

Fig. 7.11 Average, high-percentile and low-percentile competence profiles in a vocational class

learners makes it possible for the trainers to develop targeted forms of training that address individual needs, thereby achieving a considerably higher level of individual support.

3. The teacher can see which dimensions of the concept of learning areas were imparted to what extent so as to have an effect on the trainees' competences. On the basis of the test results the organization of teaching can be reflected and improved specifically for each of the eight competence components. If some of the components are continuously weaker developed than the others, the reason is probably a systematic deficit in the training programme. If, on the other hand, the variation of the distinctions is strong, this can be attributed to the training conditions at the level of the single enterprise.
4. Spider diagrams can also be used for the presentation of aggregate data. This is reasonable whenever the influence of specific training conditions or personal characteristics like prior school attainments on the competence profiles are to be identified.

Figure 7.11 shows an average competence profile of second-year trainees in the occupation of electronics technician for process engineering and, for comparison, the competence profiles of the highest and the lowest percentile. What is remarkable

in this result is that the concept of complete work activity, being one of the core ideas of vocational education, could not be fully implemented in this case.

Conclusion: It had been shown before in a number of studies in teaching and learning research, which were analyzed in a comprehensive project by John Hattie (2008) that the communication between teachers and students and especially the feedback with regard to the learning achievements of each student is of crucial importance for the learning process. The production of spider diagrams that visualize the trainees' competence profiles is an instrument that helps teachers and trainers to discuss the competence development with their trainees. This way of visualizing the test results is a considerable contribution to making competence diagnostics and the guidance of learners more objective. However, the effectiveness of this type of learning feedback depends on the feedback being delivered within a reasonably short period when the memory of the test situation and the related experience is still fresh.

When the framework for the evaluation of test results is used in a simplified form for the self-evaluation of training projects by the trainees, then trainees have the opportunity to become aware of the relationship between their own learning behavior and the results of the competence development process.

7.5 The Contribution of the Vocational School to the Trainees' Competence Development

From the trainees' point of view, a good cooperation between the learning venues school and enterprise and thus a good interplay of theoretical and practical training has been realized only to a limited extent or not at all. The vocational school and the teachers are viewed by the trainees/students as an add-on to their training, and their expectations towards the school's contribution to their professional qualification are low.

The analysis of the context data of the COMET survey shows an attitude that is contrary to the objective test results: Only one quarter of the trainees in process engineering and one third of the trainees in power engineering and building systems are not satisfied with their performance in the vocational school. The vast majority does not seem to have a problem with their school achievements.

The contradiction with the objective performance deficits – judged by the objectives of vocational education and school instruction – can be explained only by the fact that the students do not expect more from the vocational school than their actual performance. They obviously have no idea what the professional competence in their training occupation really is about. Otherwise it could not be explained why late arrival at school and absenteeism are apparently consistent with an overall satisfaction with the vocational school. This image is rounded out by the statement made by two thirds of the students that disturbing the lessons is part of the school routine. This means that the esteem of the vocational school and the teachers is also based on the fact that the students face no real demands with regard to their performance and commitment.

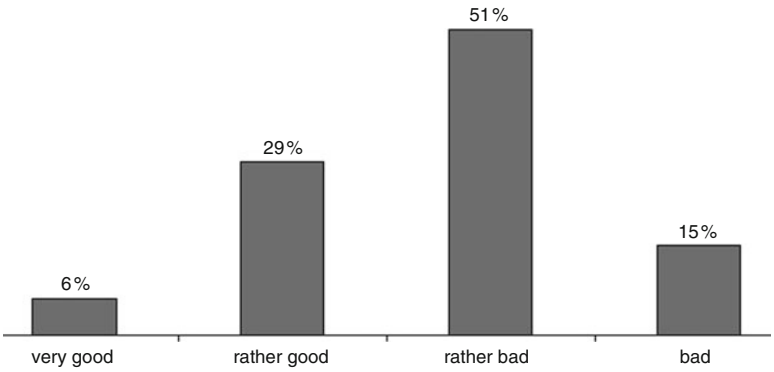

Fig. 7.12 Trainees' assessment of the cooperation of learning venues

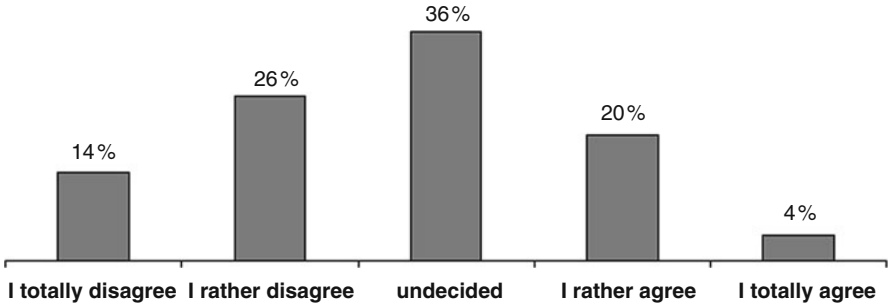

Fig. 7.13 Trainees' assessment of the utility of school instruction for the work in the company

This view is confirmed by the trainees' assessment of the cooperation between the learning venues and the coordination of school contents and work practice. Only one third of the students think that the interplay of school-based and work-based learning is successful (Fig. 7.12).

In addition, only 24% of the trainees hold the opinion that the instruction in the vocational school helps them to respond adequately to the tasks and problems of practical work (Fig. 7.13).

The work of the vocational school is regarded as important for the training process in those cases where the cooperation between the school and the training enterprise is rated positively (Fig. 7.14).

In the minds of the trainees, the obligation associated with company-based training and work is apparently contrasted by a low commitment to learning in the vocational school. A hypothesis for further investigation is that this attitude reflects the objective conditions of dual vocational education and training. These include the fact that the Vocational Training Act, being a federal law, leaves out the vocational schools as the federal government is not responsible for them. To put it bluntly, this means that

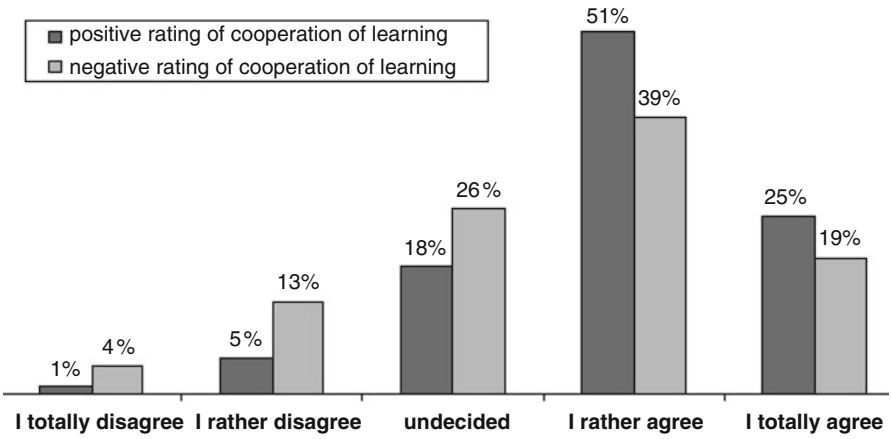

Fig. 7.14 Trainees' assessment of the relevance of school instruction for the training process in relation to the quality of cooperation between school and enterprise

the role of the vocational school in the training process is at best supplementary. This is expressed particularly in the practice of assessment. Especially those VET students who are not interested in obtaining a school qualification that would give them access to higher education virtually abandon the vocational school and regard it simply as a welcome break in their work routine.

The vocational school has only limited opportunities to support the professional competence development and the development of professional identity of the students. This is the case even when the teachers themselves are committed and highly motivated. The results of the study suggest that it is worth investigating whether a better institutional linkage of the vocational school with the VET system can significantly improve the quality of school instruction. This would involve in particular international comparisons with countries where the vocational schools take part in the responsibility for the training process, including examinations. Examples would be Austria, Denmark and Switzerland, i.e. countries with a long-standing tradition of dual vocational education and training.

7.6 Situated Competence: Commitment, Professional Identity, and the Interplay with Training Conditions in the School and the Enterprise

7.6.1 Commitment and Professional Identity

The scores for all aspects of occupational commitment are slightly higher in industry than in crafts. There is no significant change from the second to the third year. The absence of a correlation between commitment and professional competence

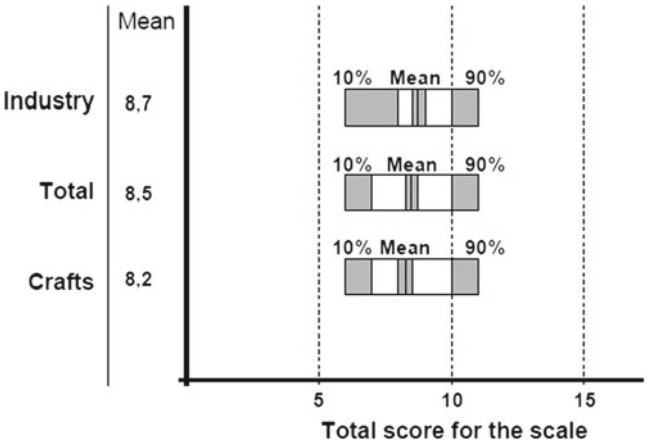

Fig. 7.15 Percentile bands for the scale "work ethic"

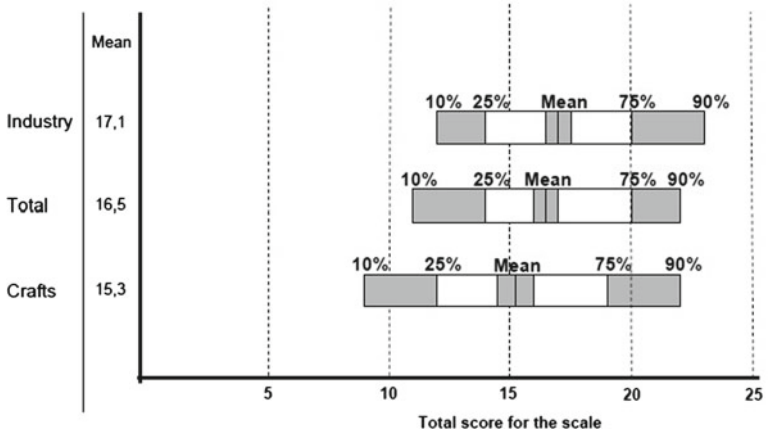

Fig. 7.16 Percentile bands for the scale "occupational commitment"

suggests the following conclusion: Occupational commitment (as well as other types of commitment) is a relatively independent aspect of professional competence that cannot simply be transformed into professional competence to act.

The remarkable differences between the two occupations in terms of professional competence almost disappear when it comes to commitment. The percentile bands on the strength of the different normative aspects of commitment in the two occupations show that the trainees in process engineering reach slightly (but significantly) higher scores in all three areas (Figs. 7.15, 7.16, 7.17).

As already described with a view to competence development (cf. Sect. 7.2) there is no change in commitment. There is neither an increase of the values from

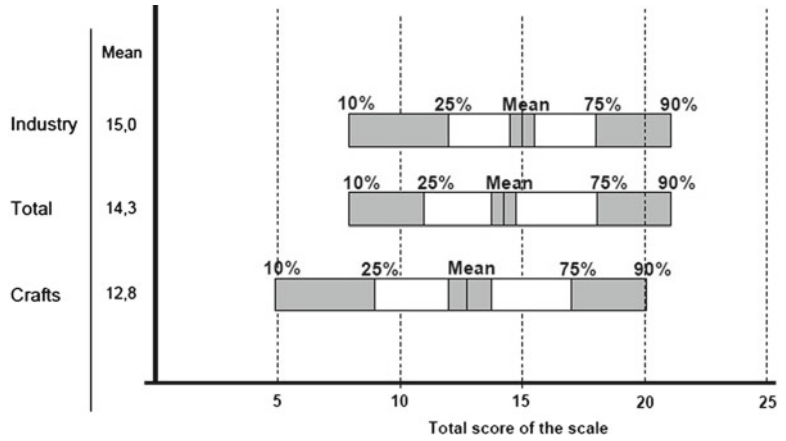

Fig. 7.17 Percentile bands for the scale "organizational commitment"

the second to the third training year nor a shift between the categories, e.g. to a greater emphasis on occupational commitment.

In addition there is no *significant* relationship between the scores for professional competence and the scores for professional identity and commitment. This cannot be explained as an artifact caused by the difficulty of the levels – there is also no correlation with the different competence levels including functional competence. For the time being it must therefore be assumed that the phenomena are independent of each other. Neither the development of professional identity nor the strength or the normative aspect of commitment are directly transformed into professional competence.

A possible explanation of the unexpected independence of professional identity and commitment might be the specific situation of trainees. Already the attainment of full professional competence is a process that extends beyond the training period (cf. Rauner et al. 2009). This is all the more true of the development of professional identity and commitment. As regards the development of professional identity, the data suggest the hypothesis that it is only after having reached a certain level that the sense of professional identity can be transformed into competence in problem solving. This level has not been reached by many of the trainees.

One of the hypotheses that guided the construction of the commitment scales was that the different normative aspects or areas of commitment also have different impacts on competence development. More specifically, occupational commitment was expected to have a stronger effect than organizational commitment. The abstract work ethic, making no reference to the concrete contents of the job, was expected to have the smallest impact on the development of professional competence. Another question was whether a shift of the dominating aspect of commitment could be observed in the course of the training period. It was expected that a greater emphasis

would be put on occupational commitment as soon as the process of identification with the occupational role was completed, which might well have been the case already in the third year of training.

Neither of the two effects, however, is confirmed by the data. A direct relationship between occupational commitment and professional competence cannot be demonstrated, and the same is true for the other aspects of commitment. The dominating aspects of commitment change only little and remain stable over the training period. A possible explanation would be that either the survey methodology is not precise enough or the trainees themselves draw no distinction between different types of commitment.

7.6.2 Professional Competence and Its Context

The development of professional competence is influenced above all by the prior school attainments. A negative effect of an immigrant background could not be identified – the acquisition of competence in the course of vocational training is only little affected by possible language problems. As regards the concrete organization of training in the enterprises it is especially the degree of work process orientation that has an effect on the development of professional competence.

Besides sociodemographic variables and variables about motivation, items on learning at the enterprise were employed as part of the context survey as described in Chap. 4.

With the exception of school qualifications there are hardly any relevant connections between the context data and the professional competence. If there are, they can be attributed to the two different occupations (like the number of employees in the company, for instance).[2]

When it comes to a comparison with the PISA results, the absence of a relationship must be particularly emphasized. The immigrant background, which is a major explanatory factor for the differences in the PISA results, was described even more precisely in the COMET study. Instead of focusing on nationality or citizenship, which is becoming less important already for the parents of third-generation immigrants, we asked about the language preferably spoken at home. Effects of the immigrant background, if any, should become all the more visible when characteristics like this are surveyed because an insufficient command of the German language is commonly regarded as a major obstacle to educational attainments. The COMET findings, however, do not reveal any correlation between professional competence and the language spoken at home. The specific contents of vocational education and the predominant ways of acquiring professional competence in the dual system appear to be less discriminating than academic education. There is also no correlation between the gender of trainees and their professional competence.

A weak effect with correlation coefficients between .2 and .3 for the competence levels and the overall test score exists with regard to the population of the place of

[2] A relationship is considered relevant when the correlation coefficient for the different competence levels and the overall score in the test assignments is at least 0.2.

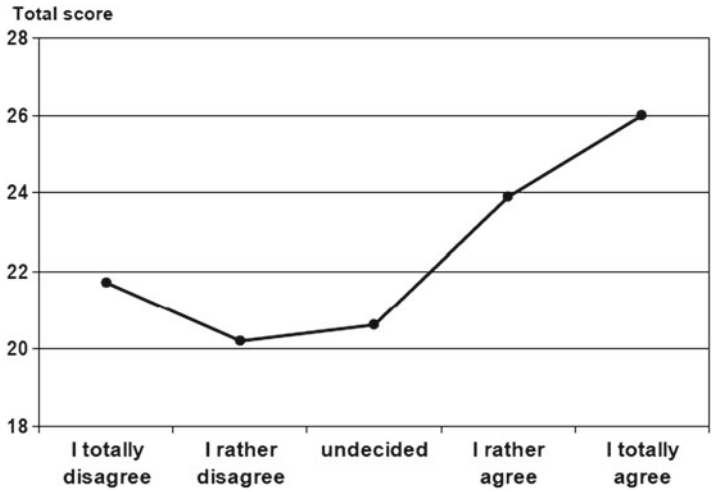

Fig. 7.18 Correlation between professional competence and the item "I become acquainted with other business processes in the company besides my own core tasks"

residence. In smaller towns the conditions for vocational learning seem to be somewhat better. Interestingly this does not hold for the commitment and the development of professional identity. These two are independent from the size of the home town.

There is one more context variable that shows a relevant correlation with professional competence: the question as to whether trainees become acquainted with other business processes besides their own professional tasks (Fig. 7.18).

This is also a weak correlation, showing *r* coefficients between .2 and .3 (.26 for the overall test score). However, the degree of work and business process orientation implied in this item is the only factor that influences the development of professional competence. The preeminent role of work and business process orientation for the quality of training and the performance of the trainees as described by the QEK studies on the quality of vocational education (cf. Heinemann and Rauner 2008; Rauner et al. 2009) is thus confirmed.

7.6.3 Occupational Commitment and Its Context

The analysis of the relationship between the context variables and the different aspects of commitment as well as the development of professional identity leads to a specific pattern. Wherever correlations exist, they concern all aspects of commitment. These correlations are usually strongest with regard to the organizational commitment. Correlations with occupational commitment are somewhat weaker, and these are followed by professional identity and work ethic.

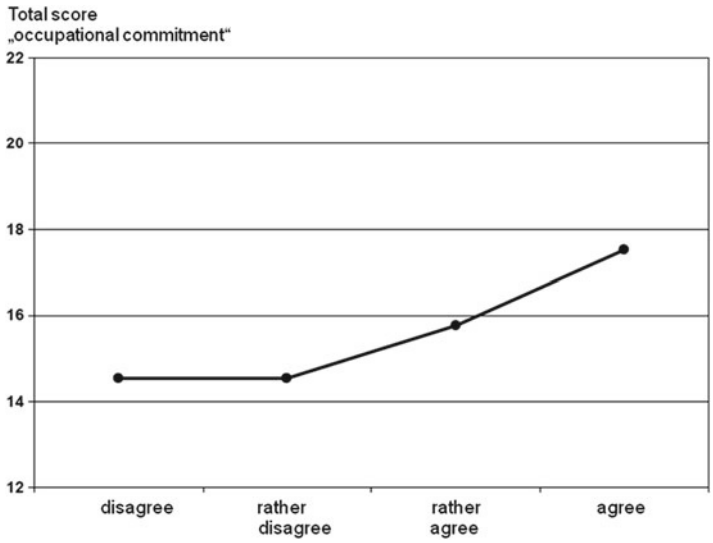

Fig. 7.19 Correlation between occupational commitment and the item "The working atmosphere can be described as rather impersonal"

Relevant effects on commitment and the development of professional identity can first be observed with regard to the motives for choosing the occupation. Trainees were asked six questions on this topic. It made no significant difference whether the choice of occupation was influenced by friends or relatives or whether the training was seen as a basis for future higher education. The question whether trainees aimed specifically at a training programme in their current training enterprise was quite plausibly correlated the strongest with occupational commitment ($r = .4$). The correlation with occupational commitment was still relatively strong ($r = .31$) while the effects on professional identity and work ethic are (very) weak ($r = .25$ and $r = .19$). The question as to whether the training occupation was actually the desired occupation correlates strongly with occupational commitment ($r = .46$). Apart from organizational commitment ($r = .36$) this specific motivation also supports the development of professional identity ($r = .33$). The effects on the general work ethic, on the other hand, are quite weak.

Concerning the working atmosphere it was relevant above all whether employees support each other and whether there is a personal atmosphere in the company. The correlation between occupational commitment and atmosphere is $r = .22$. The value for organizational commitment is .36, for work ethic it is .23 and for the development of professional identity it is .21. The figures for the mutual support of colleagues are a little higher ($r = .3$; .43; .29 and .27) (Fig. 7.19).

It is particularly the personal interaction of employees that is crucial for the development of commitment and professional identity of the trainees. The question as to how intense competition among colleagues and control by management are plays only a minor part.

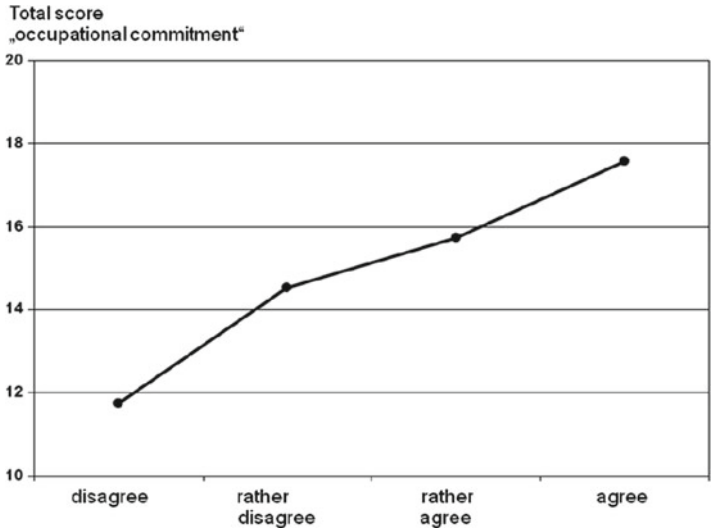

Fig. 7.20 Correlation between occupational commitment and the item "Whenever something needs to be clarified with regard to my training there is always a contact person available"

As regards the behavior of colleagues towards the trainees it is also the variables representing personal relationships that play a major role. There is a positive correlation between occupational commitment and the availability of a contact person ($r = .29$). The values for organizational commitment, work ethic and development of professional identity are .4, .2 and .25 (Fig. 7.20).

Other items referring to the behavior of colleagues, such as the question whether trainees are regarded by colleagues as a disturbance, are supported by colleagues or just left alone, show only weak effects. This can be explained above all by the fact that such responses from colleagues virtually never occur.

The items regarding the integration into the expert culture of the enterprise all show significant effects on commitment and the development of professional identity. Moreover there are (weak) correlations with professional competence development. The following chart shows the correlation between the item "When I work on a task I have professional support and feedback" and occupational commitment ($r = .31$) (Fig. 7.21).

The correlations with organizational commitment ($r = .4$), work ethic (.29) and professional identity (.3) are also noteworthy. The values for other items that refer to trust between trainees and skilled workers are similar.

The items on the variety of work tasks show correlations with occupational commitment and the development of professional identity. Here it is particularly relevant how meaningful the work tasks are. The correlation between this item and the occupational commitment of trainees is $r = .33$ (Fig. 7.22).

Furthermore, there is hardly any other item that correlates so strongly with the development of professional identity ($r = .34$). The coefficients for organizational

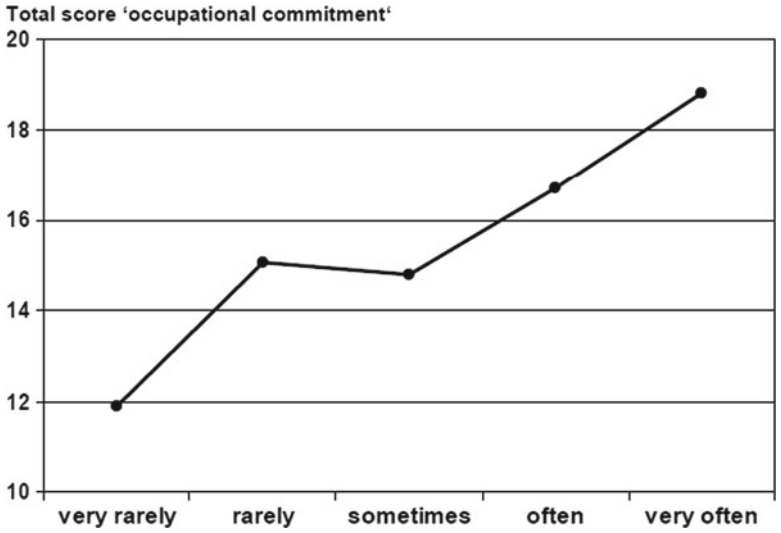

Fig. 7.21 Correlation between occupational commitment and the item "When I work on a task I have professional support and feedback"

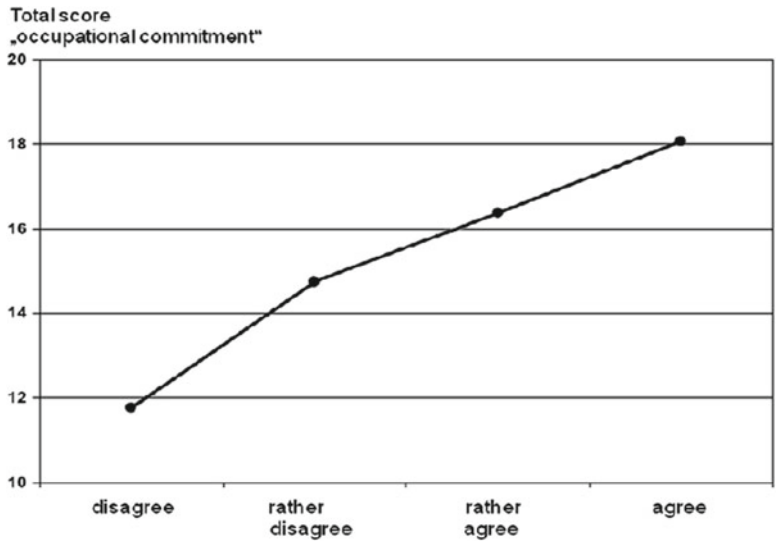

Fig. 7.22 Correlation between occupational commitment and the item "In the training I have the opportunity to do a variety of things and to employ a vast array of knowledge and skills"

commitment (.4) and work ethic (.3) are also considerably high. The other items of this questionnaire section, on the other hand, are less relevant. These include questions concerning whether the work assignments represent the occupational profile and whether they stimulate contacts with colleagues.

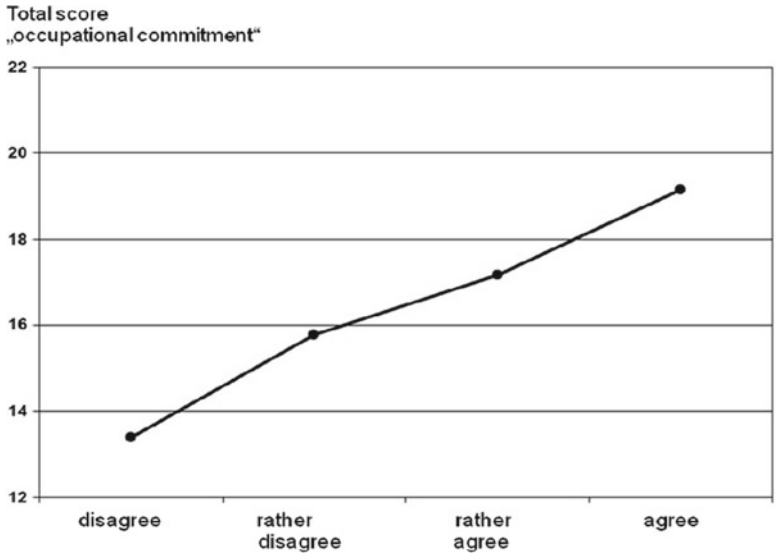

Fig. 7.23 Correlation between occupational commitment and the item "The results of my work activities are highly relevant for the department/unit in which I work"

The items referring to the importance of the work tasks fulfilled by the trainees show weak correlations with commitment and professional identity. The correlations are stronger when the relevance of tasks is experienced by the trainees in their closer environment, i.e. when the tasks refer to their immediate workplace environment instead of the enterprise as a whole. An example is the item "The results of my work activities are highly relevant for the department/unit in which I work." (Fig. 7.23)

Here the correlation coefficient is .28 for occupational commitment, .3 for organizational commitment, .15 for work ethic and .29 for professional identity.

The items concerning the matching between the difficulty of work tasks and the skills of the trainees correlate with commitment and professional identity when they focus on whether and to what extent the trainees can use their skills in the work process. The mere difficulty of tasks, on the other hand, plays a minor part and shows hardly any effect. Figure 7.24 depicts the correlation of the item "I can demonstrate what I have learned in the area concerned" with occupational commitment ($r = .4$). The values for organizational commitment, work ethic and professional identity are.4, .27 and .34.

7.7 Conclusion

In general the organization of in-company training tends to support all aspects of commitment, the effect on organizational commitment usually being slightly stronger. Intrinsic motivations for choosing the training occupation, e.g. the desire to work in

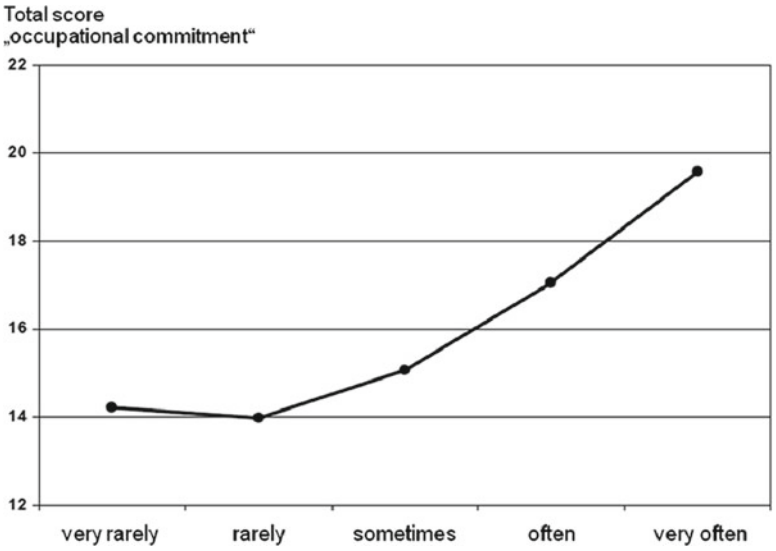

Fig. 7.24 Correlation between occupational commitment and the item "I can demonstrate what I have learned in the area concerned"

a particular occupation or a particular enterprise, stimulate commitment as well as the development of professional identity.

The aspect of work and business process orientation has a cardinal function with regard to the development of professional competence, commitment and professional identity. This aspect has an impact on all dimensions. The other characteristics of the organization of training in the enterprise have effects only on the commitment of trainees and the development of their professional identity. These correlations are strongest for the items that focus on trust between trainees and employees.

The fulfillment of work assignments in the company has a positive effect on commitment and professional identity when the trainees are given the opportunity to apply their knowledge and skills in complex and meaningful tasks and when the relevance of these tasks is visible in their own working environment.

While the hypothesis was confirmed that the prior school attainments have a strong impact on the process of competence development, the immigrant background of trainees has no effect.

These results suggest a number of recommendations for VET planning and practice:

1. The context of work and the orientation towards business processes support a thorough understanding of the occupation and a highly developed professional identity and commitment. Accordingly this should be taken into consideration as a criterion for curriculum development and for the organization of vocational education and training programmes.

2. The support of identity development is a pedagogical task in its own right and does not emerge as a by-product during the process of professional qualification. A well-functioning cooperation between learning venues and a training that builds on in-company work assignments and business processes from the very start supports occupational as well as organizational commitment.
3. The motivation of trainees is somewhat diffuse and builds upon identification with the enterprise as well as with the occupation. Obviously the development of a genuine professional identity is delayed by a lack of business process orientation in the training and thus a lack of experience with the real work context. A possible consequence would be to put more emphasis on the novice-expert paradigm in the design of vocational education and training programmes.
4. The trainees' insights in the advantages and disadvantages of their training environment are necessarily limited so that teachers and trainers should be included in the survey of context data.

References

Baumert, J., Klieme, E., Neubrand, M., Prenzel, M., Schiefele, U., Schneider, W., Stanat, P., Tillmann, K.-J., & Weiß, M. (2001). *PISA 2000: Basiskompetenzen von Schülerinnen und Schülern im internationalen Vergleich*. Opladen: Leske + Budrich.

Deutsches PISA-Konsortium. (Hg.). (2002). *PISA 2000 – Die Länder der Bundesrepublik Deutschland im Vergleich*. Opladen: Leske + Budrich.

Deutsches PISA-Konsortium. (Hg.). (2005). *PISA 2003. Der Bildungsstand der Jugendlichen in Deutschland – Ergebnisse des zweiten internationalen Vergleichs*. Münster: Waxmann.

Hattie, J. (2008). *What is the nature of evidence that makes a difference to learning?* Internetquelle: http://www.acer.edu.au/enews/0508_Hattie.html. Zugriff 29 Oct 2010.

Heinemann, L., & Rauner, F. (2008). *Identität und Engagement: Zur Konstruktion eines Instruments zur Beschreibung der Entwicklung beruflichen Engagements und beruflicher Identität* (A+B Forschungsberichte 01/2008). Bremen/Heidelberg/Karlsruhe.

Chapter 8
Results of the Main Phase

The research and development tasks of the COMET project in 2009 were extended on the basis of the results from 2008 by the inclusion of students from three technical colleges (*Fachschulen*) and the establishment of a cooperation with China involving 800 trainees and students from technical colleges in the Beijing region.

8.1 Inclusion of Students from Technical Colleges

In Germany, technical colleges (*Fachschulen*) are part of the system of continuing vocational education and training. They typically offer 2-year training programmes in the fields of agriculture, design, technology, business and social work (cf. KMK 2002, 22 f.). Access to technical colleges requires the completion of a relevant initial VET programme and a minimum work experience of 1 year. The training programmes at technical colleges usually last four semesters (full-time). The curriculum comprises at least 2,400 h of instruction, of which 1,800–2,000 h are allocated to the vocational subject while the remainder is assigned to general education. The programme is completed with a state examination, upon which a qualification like "Staatlich geprüfter Techniker" (state-certified technician) is awarded. At some technical colleges, the training programme also involves the preparation for the master craftsman's examination.

Technical colleges are usually established as departments or programmes within vocational schools. In the field of social work and in some other cases, there are also independent technical colleges. One example is the Technikakademie Weilburg, whose name emphasizes that this institution claims an equal standing with institutions of tertiary education, e. g. the universities of cooperative education (*Berufsakademien*). The qualifications awarded by the latter are equivalent to the baccalaureate level. When the initial training programme and the mandatory work experience prior to the studies at the technical college are taken into consideration, then this learning

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path has a duration of at least 6 years. Given that the graduates of technical colleges have a high level of practical experience, their familiarization with the new responsibilities as state-certified engineers takes remarkably little time.

Besides the full-time programmes there are also part-time programmes with a duration of 4 years. As a considerable workload is associated with this way of studying alongside the job, the drop-out rate is relatively high. In some cases, enterprises support the studies of their employees at technical colleges by adjusting their human resource development accordingly. In practice this means that the students are given the opportunity to familiarize with their new senior staff functions in the company as they proceed in their training programme at the technical college. Two reasons were decisive for the inclusion of students from technical colleges in the COMET study:

1. The technical college is a school type that is formally situated between the upper secondary level and the level of tertiary education. The entry requirements of completed initial VET and relevant work experience are linked with a study programme that builds upon the practical competence of the students and aims to deepen this competence with a view to practice and academic knowledge. Here the organization of the subject-specific curriculum in terms of content becomes a relevant research question. Does the curriculum follow the concept of learning areas, or does it follow rather the relevant academic subjects? The latter would lead to a strong orientation towards functional competence. If the first approach is taken instead, one would have to expect that the competences of the 2nd and 3rd level are stronger.
2. The locations of the technical colleges are an interesting issue for educational planning. An argument in favor of the integration of technical colleges into vocational schools is the observation that the higher educational level of the technical college programmes positively influences the vocational school. Teachers face a stronger professional challenge from the students of technical college programmes, which supports the informal learning of teachers.

The participation of approximately 60 students from three technical colleges, including one independent college, was organized as an explorative case study that aimed to generate hypotheses in line with the research problems identified above. At the same time the sample was big enough to include the test results in the comparative COMET study.

8.2 Participation of Chinese Teachers and Students

The participation of Chinese teachers and students in the COMET project in the course of an international comparison assessment requires the clarification of some important aspects.

The initiative for the participation of Chinese trainees and students from 2009 onwards came from the Institute for Vocational Education of the Academy of Pedagogical Sciences (Beijing). The sub-project “COMET Beijing” is embedded in

a larger initiative for the implementation of VET reforms in China (cf. Rauner and Zhao 2009, 327 ff.). In the course of the modernization of learning and teaching methods in the provinces that have developed VET structures, the continuing professional development of teachers is now emphasizing the concept of learning areas as well as project-based learning by means of learning tasks. Having teachers' continuing education based on didactical and pedagogical concepts that have been shaping vocational-pedagogical research and discussion in Germany for two decades is a result of intensive developmental cooperation between Germany and China in the field of vocational education. The projects in this field were funded by the GTZ and several foundations. In recent years there has been a targeted funding of cooperation projects from Chinese national and regional VET reform programmes. The cooperation in research and development is facilitated by the fact that many Chinese VET educationists studied in Germany and are now fulfilling tasks in the education of VET teachers, the administration of the VET system and in VET research.

Vocational education and training in China is school-based. VET programmes usually comprise 2 years of school instruction and 1 year of on-the-job training in the enterprises. The VET schools and colleges are responsible for the management of the workplace training phase as well. This type of alternating duality takes place at:

- Vocational secondary schools (3 years)
- Technical secondary schools (3–4 years)
- Skilled worker schools (3–4 years), all of which belong to the level of secondary education
- Vocational colleges (higher vocational education)

There are only small differences between the three types of school-based vocational education and training at the secondary level. They are the effect of the different organizational structures. Upon completion of the school-based phase of the training programme the trainees are awarded a school certificate. In addition there is a vocational entry certificate that can be awarded after an examination by the employment agency.

The vocational secondary school consists of a lower secondary and an upper secondary level. These schools are operated mostly by regional education and training authorities, mass organizations (e. g. trade unions) and recently by private organizations. The lower level of vocational secondary schools is relevant only for underdeveloped rural areas. In these areas, the 3-year lower secondary education at vocational secondary schools serves the purpose of vocational education after 6 years of elementary schooling. Another variant is a 3-year lower secondary programme of general education that is followed by 1 year of prevocational education.

At the upper level of vocational secondary schools, trainees are qualified for the skilled workers' level in 3-year programmes. The domains covered are craft trades, technology, business and agriculture. The entry requirement is the completion of lower secondary education. The training at vocational secondary schools is completed with a certificate. In rural areas students occasionally have the opportunity to complete specific modules of a training programme.

Table 8.1 Number of first-year students enrolled in upper secondary education

Year	Total	Vocational secondary schools	Technical secondary schools	Skilled worker schools
2001	3,999,400	1,550,500	1,887,900	551,000
2002	4,697,300	1,873,600	2,128,600	695,100
2003	5,095,300	1,972,600	2,268,600	854,100
2004	5,662,000	2,126,600	2,438,400	1,097,000
2005	6,556,600	2,482,100	2,890,800	1,183,700

Source: Office for Statistics of the People's Republic of China, 2007

The technical secondary school plays a prominent role in school-based vocational education. The entry requirement is the completion of lower secondary education. Zhao points out that the original mission of the technical secondary schools was to train technicians. Due to an inadequate supply of qualified teachers and a lack of work experience on the part of the students, however, these efforts have not been a success (Zhao 2003, 13). The coexistence of vocational secondary schools and technical vocational schools has already been abandoned in the training practice. Vocational secondary schools, technical secondary schools and skilled worker schools are now covered by the generic term "secondary vocational-technical schools".

Skilled worker schools are roughly comparable with vocational secondary schools. The difference is that skilled worker schools are usually operated by the labor market office, large enterprises and the municipal authorities under the leadership of the labor market office. Traditionally the training programmes at skilled worker schools are oriented towards industrial occupations. In recent years these schools have developed new business areas such as continuing vocational education and training, retraining of unemployed persons as well as short-term training. The quantitative development of school-based vocational education between 2001 and 2005 is shown in the following Table 8.1.

Since the mid-1990s Chinese VET policy lays a particular emphasis on the development of higher vocational education. The main objective of higher vocational education is to educate "highly skilled workers at the front of production and service" at practice-oriented and regional colleges in short-cycle programmes of 2 or 3 years. The degree awarded is equivalent to the one that can be obtained in general short-cycle programmes (zhuan ke). In comparison to ordinary study programmes, the programmes of higher vocational education are more flexible and practice-oriented.

The pressure of families to give their children the opportunity to attend higher education is very high under the conditions of the one-child policy. Accordingly the programmes of higher vocational education are becoming more important. The opening up of the universities for higher vocational education is therefore not so much driven by the qualification requirements of the enterprises, but rather a symptom of a "college for all" policy in the conurbations.

The primary goal of Chinese VET, like in Germany, is the attainment of vocational aptitude. The principle of the dual organization of VET is a key factor for the realization of this objective. Unlike German dual VET, the school-based VET programmes in China are based on the model of alternating duality. The instruction at vocational schools is

organized not according to occupational profiles, but according to subjects or vocational disciplines. Therefore the relevant indicator for the comparison of VET programmes consists in the test assignments. The suitability of these assignments for the evaluation of professional competence in the area of electrical engineering was confirmed by the Chinese pedagogues without any reservation. In their view the occupational profile is covered to 77% by the assignments.

This supports the hypothesis that similar structures emerge in the employment systems throughout the world, which make it possible to use the criterion of professional validity for the comparison of VET or higher education programmes.

Approximately 50 VET pedagogues from vocational schools as well as from VET administration and VET research participated in a 7-day inception seminar for the COMET Beijing project in December 2008. The main topics of the seminar were the foundations of the test concept as well as the test instruments and test arrangements. Subsequently several work groups were occupied with the translation of the test instruments and test assignments as well as the preparation of the pretest.

After the inception seminar a written agreement was concluded with the representatives of the VET administration, in which the details of the project implementation and the publication of results were specified and in which it was agreed that the competence assessment would be carried out in accordance with the COMET competence and assessment model and with the help of the test assignments developed in the German COMET project. The competence model was accepted by the Chinese VET experts as an appropriate basis for the assessment of professional competence.

The distribution of participants from the various school types in the pilot phase of the COMET Beijing project (test date April 2009) was as follows:

- 177 test persons from technical secondary schools (second year: $n=60$; third year: $n=117$);
- 217 test persons from skilled worker schools (second year: $n=167$; third year: $n=50$);
- 426 test persons from vocational colleges (second year: $n=327$; third year: $n=99$).

Additionally a group of 38 VET teachers took part in the COMET test. The research interest was concerned with the competence profiles and with the question how developed the professional competence is at the levels of process and shaping competence. The test results were particularly expected to deliver information about whether and how the continuing education measures for teachers had an impact on the competence profiles of VET teachers.

8.3 General Findings: Comparison of the Test Groups

The COMET methodology makes it possible to test, with identical sets of test assignments, the professional competence of trainees, students of technical colleges and teachers/trainers in a given professional domain under a comparative perspective.

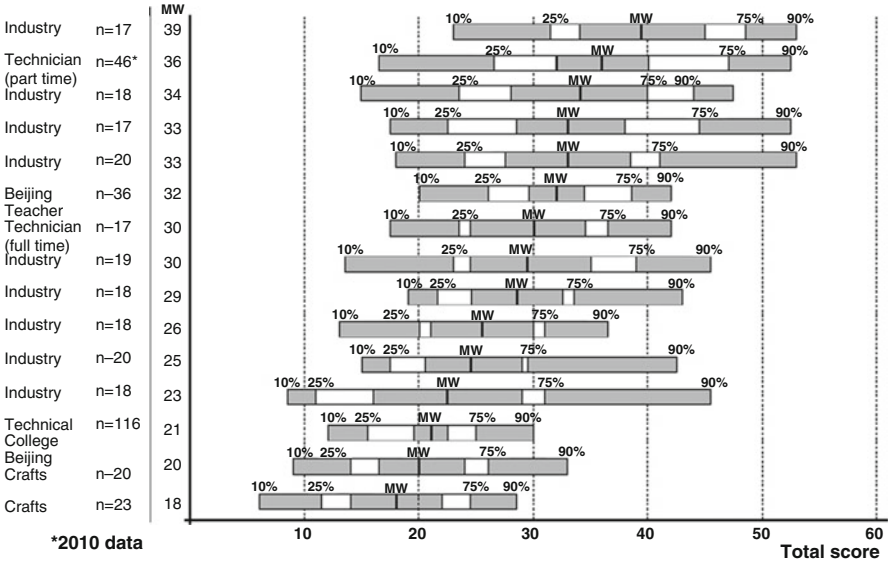

Fig. 8.1 Percentile bands for trainees' professional competence at class level (2009 test, first assignment) ("*MW*" means "arithmetic average")

The heterogeneity of the test results for different test groups and participants within test groups can once again be visualized by percentile bands. The means of the test groups of electronics technicians for power engineering and building systems on the one hand and technical college students from Frankfurt and Hanau on the other differ by 16 points. This is roughly equivalent to 1 year of training in the dual system. The low level of competence of the trainees in power engineering is also an indicator for a comparatively weakly developed professional identity and a lower level of occupational commitment in comparison to other training occupations. Figure 8.1 shows the test groups split up by classes. Classes that were too small ($n < 15$) were not taken into account for this overview. This is the reason why there are only two power engineering classes in the image.

The figure shows that there is not only a heterogeneous performance within the test group, but also considerable differences from one process engineering class to another. The mean of the best process engineering class is 39 points for the first test assignment while the lowest performing class has a mean of 23, which is a difference of 16 points.

When these test results are visualized by radar charts one can gain further information about the various competence distinctions on the basis of the resulting competence profiles. The students at technical colleges that are integrated in vocational schools (FSB) attain the highest competence level of all test groups and a competence profile in which processual and shaping competence are quite strong (Fig. 8.2). This result shows that in this case the implementation of the concept of learning areas has been successful.

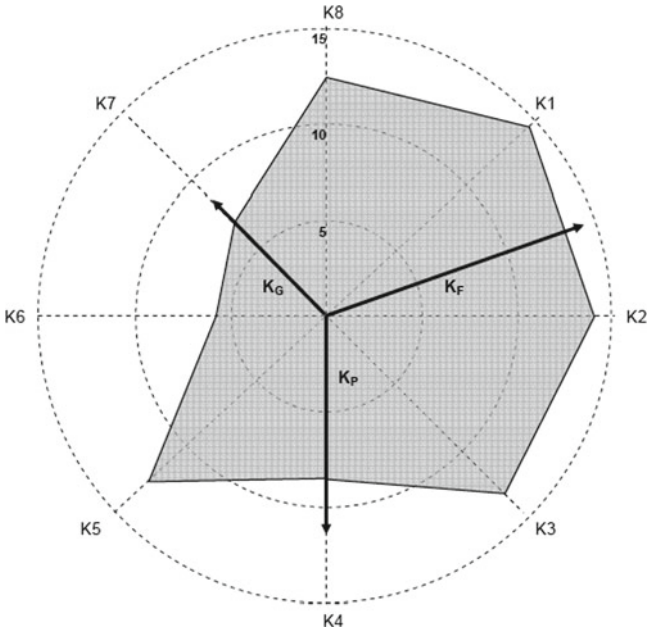

Fig. 8.2 Students of technical colleges within vocational schools ($n = 27$)

The test group of teachers (Beijing) has a strong functional (theoretical) competence (Fig. 8.3). With regard to the embedding of solutions into the business operations and work processes of the enterprise, the utility of solutions as well as their creativity the scores are also relatively high. On the other hand there are considerable weaknesses with regard to the competence components of economy and environmental compatibility.

The competence profile of the students at the independent technical college (TA) shows some similarities to the first two profiles, but all competence components are realized on a lower competence level (Fig. 8.4). Training deficits can be identified with regard to the components economy as well as environmental and social compatibility. Obviously the study programme is characterized by a more theoretical or academic orientation.

The competence profile of the trainees for the occupation of electronics technician for process engineering is quite similar to the profile of students at the independent technical college (TA) (Fig. 8.5). The strengths (K1, K2) and weaknesses (K4, K6, K7, K8) are immediately visible. The concept of task-oriented learning provides the opportunity to compensate these weaknesses.

The Chinese students approximately realize the same competence profile as the trainees in power engineering and building systems (Fig. 8.6). This low profile can be attributed above all to the academic teaching and learning methods. The fact that the teachers have a relatively high competence level (cf. Fig. 8.3), is an indicator of

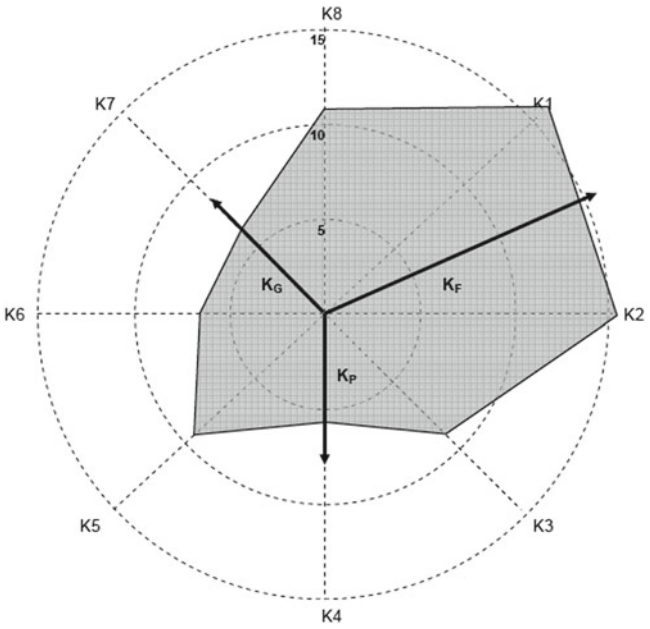

Fig. 8.3 Chinese teachers ($n = 38$)

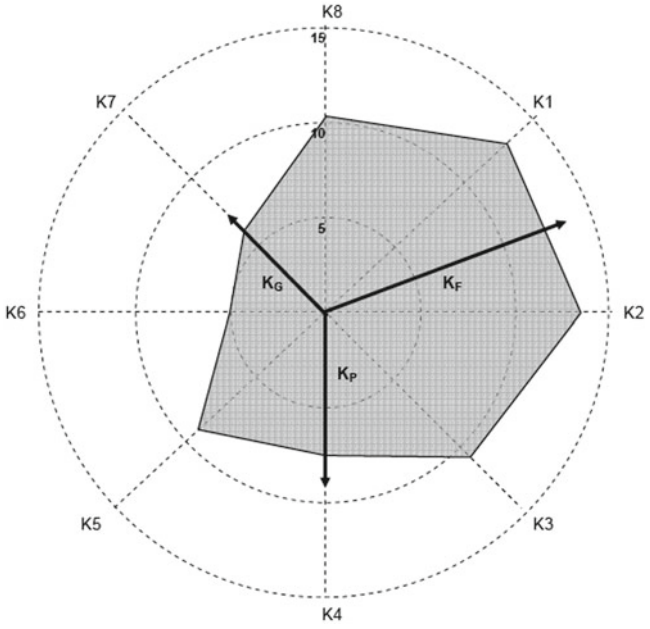

Fig. 8.4 Students of independent technical college, TA ($n = 32$)

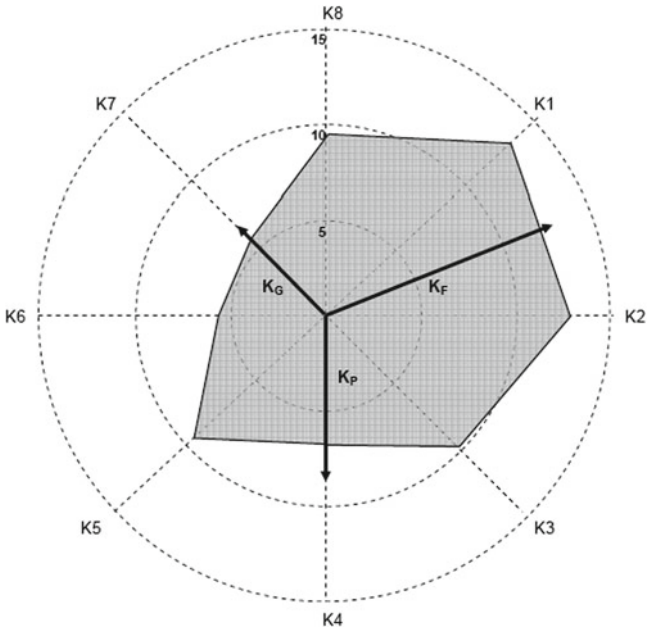

Fig. 8.5 Trainees in process engineering industry, Hessen ($n = 288$)

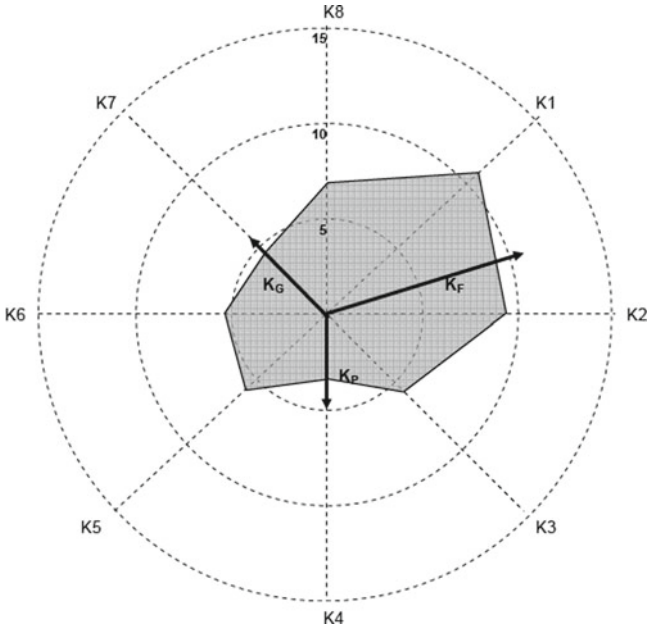

Fig. 8.6 Students at technical college Beijing ($n = 116$)

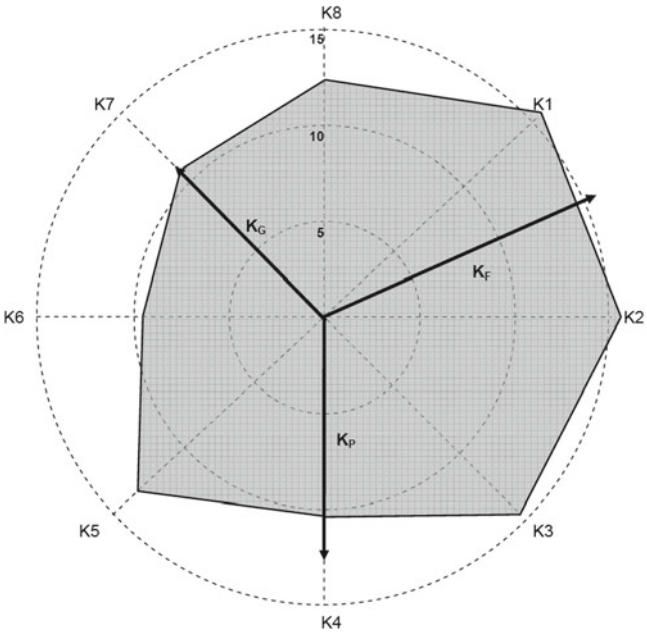

Fig. 8.7 Distribution of competence levels on the basis of the first test assignment

a transfer problem: The continuing training of the teachers has led to a successful performance in the test, but the newly acquired skills still remain to be applied in teaching.

When the research interest is focusing on the distribution of the participants across the competence levels, bar charts are chosen for the visualization of results (Fig. 8.7).

Like the radar charts, the bar charts make it possible to give a clear impression of how well the training practice succeeds in achieving the goals of vocational education and training. Moreover, two particular issues can be visualized very clearly:

– Which of the four competence levels is attained to what extent by the test groups and
– How the test groups differ in this regard.

Figure 8.7 illustrates that only the students of technical colleges within vocational schools (FSB) have the competence to solve the complex test assignments in a holistic way. One quarter attain the third competence level on the basis of the first test assignment.

The difference between the students at technical colleges and the teachers is merely that a part of the students at the independent technical college (16%) is below the first competence level. In both cases, i.e. for teachers as well as for students, the professional qualification consists in the acquisition of the ability to solve professional tasks completely and holistically.

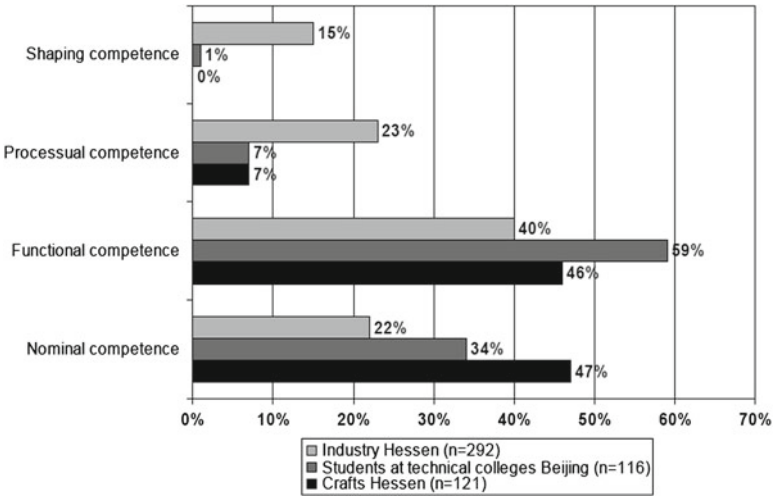

Fig. 8.8 Distribution of competence levels of the test groups process engineering (Hessen), technical college (Beijing), and power engineering and building systems (Hessen)

The following image shows the differences that exist between the three lower performing test groups with regard to the distribution of competence levels (Fig. 8.8). What is remarkable here is the high proportion of at-risk students. Furthermore it becomes clear that at least approximately one third of the trainees in process engineering in Hessen attain the second or third competence level.

On the whole it can be observed that the training objectives in terms of processual and shaping competence as defined in the curricula are well met by one of the test groups of technical college students, but not by the other test groups. The average scores or the corresponding percentile bands do not give a clue as to whether the overarching goals of vocational education have been achieved.

Conclusion: In the course of the implementation of the COMET test methodology it makes sense to use all three ways of visualizing the test results and to interpret them in an integrated perspective.

The test results give an impression of how far the trainees' competence – in the sense of cognitive performance dispositions – is developed. The test assignments were developed for trainees in dual vocational education and training. However, they strictly observe the criteria of the competence model. Any type of vocational education has the objective to make a contribution to the development of professional competence. Professional aptitude is an objective not only of dual VET, but also of school-based vocational education as well as technical colleges when a period of school instruction is followed by a phase of company-based training (alternating duality). Accordingly the test arrangement is appropriate for other groups of VET students, too. The test results also show that the test groups differ in terms of competence levels and competence profiles. These differences in competence development can be measured with high precision.

8.4 Professional Competence in Different Technical Colleges

The test results show that (German) technical colleges have a remarkable potential for qualification by virtue of their integration into a learning pathway that starts with a dual vocational training programme, includes at least 1 year of professional experience and is continued by a study programme that emphasizes work and business process orientation. The results suggest that professional competence of graduates of a professional and work process oriented programme is higher compared to those who have completed a semi-academic programme.

The competence level of students at technical colleges has a mean of 31 points and is thus considerably above the level of the trainees in the two electronics technicians' occupations (mean: 26 points) (Fig. 8.9). When the groups are compared with regard to the different competence levels, there are some more significant differences.

More than half of the students of technical colleges, namely 52.5% achieve the second and third competence level (20.3% attain the third and 32.3% the second competence level). Every second student thus is equipped with professional problem solving competence above the level of functional competence. Among the trainees the corresponding proportion is only 40%. A significant difference can also be observed with regard to the risk group. The latter accounts for 21% of the trainees whereas the share among the technical college students is only 10.2%. The remarkably high competence level of the students at technical colleges must partly be attributed to their higher general cognitive performance, their prior school education as well as their completed vocational education and work experience. An analysis of the test

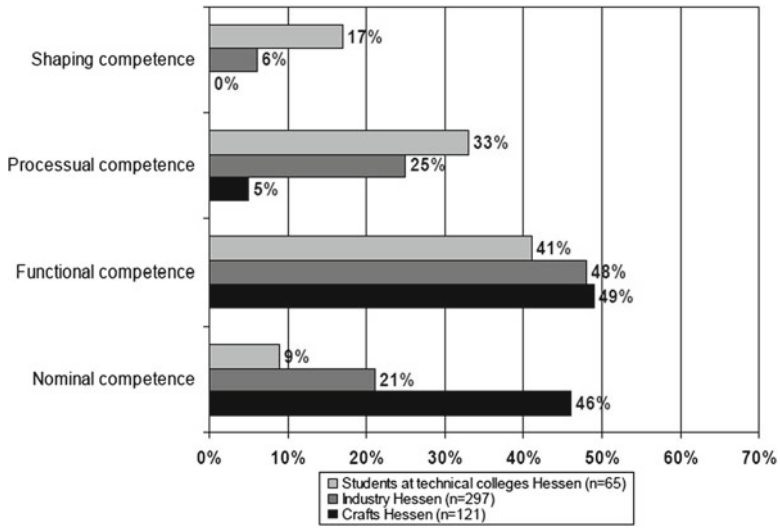

Fig. 8.9 Distribution of competence levels by test group (trainees and technical college students)

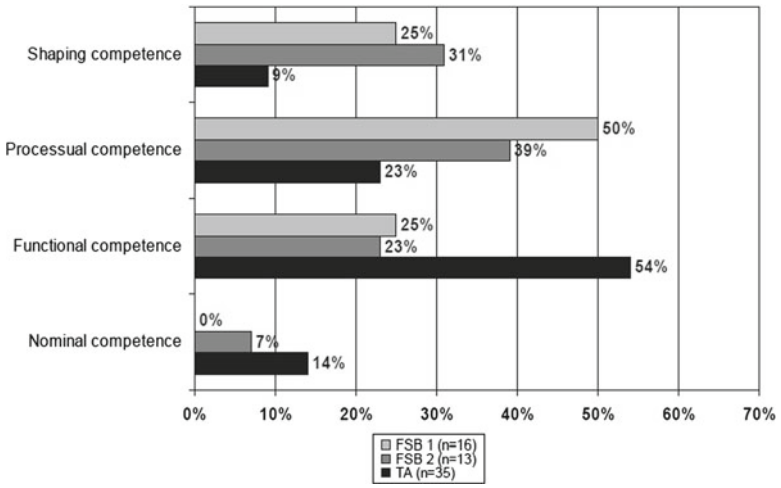

Fig. 8.10 Distribution of competence levels by school location

results according to the context data delivers information about how the factors of school-based learning influence the competence development.

A first result delivered by this analysis is that the test groups that belong to the different school locations have quite different competence profiles (Fig. 8.10).

In the test group of technical college students who were trained at one of the two vocational schools, i.e. in technical colleges that were part of a vocational school (FSB 1), the proportion of those who have attained the highest competence level is 40% while 30% reach the second level. The outcome for the test group FSB 2 is similar. The share of those who reach the second and third level is 77%. All students in the FSB 2 group reach one of the three competence levels so that the size of the risk group is zero. The group of students trained at an independent technical college (*Technikakademie*, TA) reaches an average of 26.8% and thus falls short of the competence level of the two other groups, whose average is 35%. This can be explained by the relatively high proportion of students at risk in this group (15.2%) as well as the very small figure of those who attain the third competence level (9.1%) and the relatively small proportion of those who have reached the second level (27.3%). Only about one third of the TA students reaches the second or third competence level. This is shown by the comparison of the average scores of the different test groups (Table 8.2).

This outcome is not in line with the expectations of the teachers at the TA, who give a much higher estimate of their students' competence level. This view has been confirmed by an equivalence check that was carried out between the training programme offered at the TA and a corresponding degree programme at a local university of applied sciences (cf. Müskens et al. 2009). The equivalence check, which was implemented in the course of a European project, consisted of a comparative

Table 8.2 Average scores of the test groups in the test assignments

Test group	Average score
Electronics technicians for power engineering and building systems	19.2
Electronics technicians for process engineering	26.5
Students at technical colleges Hessen (total)	31.2
Students FSB1	34.9
Students FSB2	36.5
Students TA	27.5

assessment of the content and the level of learning outcomes from the two programmes. The aim was to determine whether graduates from the TA could be exempted from taking certain modules at the university of applied sciences thanks to equivalent learning outcomes from their vocational training programme. Reference materials like curricula, module descriptions, scripts, documentations of work assignments and others were compared by means of specific evaluation tools so that the learning outcomes could be situated within the reference levels of the European Qualifications Framework. The result was that certain parts of the training programme at the TA were indeed equivalent to the corresponding parts of the programme at the university of applied sciences, and that some vocational learning outcomes actually had a higher level than the learning outcomes from the university of applied sciences.

This reflects an academic training concept that follows the model of scientific disciplines, which is also expressed by the TA's self-characterization as an "academy". The academic or semi-academic model is based on the paradigm of a practice-oriented higher education programme that leads to a bachelor degree. The equivalence check suggests that this ambitious goal is partly met by the module descriptions.

Accordingly it is of particular interest how the professional orientation and the learning situation are viewed by the students of the three groups. Apart from the German students there was also a sample of 123 students from a higher technical college in Beijing who participated in the context survey. These Chinese students have only little professional work experience. The third training year, however, is spent in enterprises. Therefore the third-year students have at least some basic work experience. Nevertheless their responses to those questions that refer to professional work are for the most part based on their expectations to their future work rather than actual experience.

The linkage of the training programmes to professional work processes varies between the different test groups. According to the survey results, the proportion of the students trained at vocational schools (as opposed to independent technical colleges) who "prefer" a work process oriented training is 66% and the share of those who "totally agree" to such a type of training is 33%. These students have a stronger vocational orientation than the TA students and the Chinese students. The learning objectives of the BFS students are much more oriented towards work processes than the learning objectives of students in semi-academic programmes.

Finally, the stronger work process orientation at vocational schools is expressed by the greater willingness of students to solve professional tasks independently.

Two different models for study programmes at the level of technical colleges can thus be identified:

– An academic or semi-academic model and
– A professional and work process oriented model.

The semi-academic model represents a shift of perspective from a process of vocational qualification to an academic degree programme. If this transformation succeeds, the outcome will be a professional degree that is associated with a competence profile nearly equivalent to the level attained by graduates of bachelor programmes. With regard to the attainment of professional aptitude – in the sense of the professional acting competence – this means that the study programme must be followed by a period of practical training on the job. This is to say that while the content of the training programme becomes more academic, the acquisition of professional competences and qualifications is postponed to the phase of familiarization in the workplace.

The professional and work process oriented model of the technical colleges that are integrated into vocational schools, on the other hand, is based on the concept of "learning areas" and thus on teaching and learning contents that aim at the acquisition of *professional* competences. It is professional tasks and their adequate, i.e. holistic solution in the sense of the COMET competence model that dominate the training process. The training at technical colleges is organized as a logical continuation of the professional career. The qualification awarded is *equivalent* to the bachelor degree, but not *of the same kind*.

Given that the COMET procedure measures professional and not just technical competence, the difference outlined above contributes to the explanation of the test results. The students from the academic or semi-academic group approach the test assignments from a more scientific and less practical point of view. This is expressed by the concentration of solutions at the level of functional competence. The relatively high proportion of students at risk could be an effect of the difficulties that many professionally oriented students have with the transition to a semi-academic type of training.

Conclusion: The relatively high share of technical college students from vocational schools who attain an advanced competence level shows that the students are capable of mastering professional work tasks largely in a holistic way and with due attention to all relevant requirements (functional, economic, ecological, social). The VET teachers were obviously successful in the implementation of the concept of learning areas in the practice of teaching and learning. However, it remains an open question how the technical college can be integrated into the VET system so that it is capable of exploiting the strengths of dual vocational training on the one hand and establishing a link to higher education on the other. To pursue these two objectives at the same time is not without risks as the examples of the semi-academic groups (TA, Beijing) show. The contradiction that appears here can be overcome only if the training at technical colleges is integrated into a continuous dual vocational learning

path that leads from initial training to the level of master degrees, thereby putting the concept of learning areas into practice to the fullest possible extent. The part-time technical college where students learn alongside their professional work is already an approximation of a higher education programme that truly leads to a professional qualification. The next step would be the establishment of part-time master degree programmes for graduates of technical colleges (and master craftsmen) that build upon the professional competences of these target groups.

8.5 Motivation of Participants

The participants' interest in the COMET test procedure is quite diverse. The motivation to take part in the test is relatively low in all test groups. In the case of the trainees for the occupation of electronics technician for process engineering the motivation is higher at the beginning but declines as the testing proceeds.

The effects of a good feedback from teachers and trainers on the learning achievement of students and trainees by means of tests and other evaluation methods are unanimously considered significant by VET researchers. Feedback in the shape of learning advice and career guidance is regarded, for good reasons, as a core element of a good learning culture.

The analysis of the test motivation in 2009 makes it possible to give a first estimate concerning whether and to what extent the COMET test procedure was seen by the participants as an additional feedback or an additional type of guidance.

There are two ways of collecting evidence on the test motivation. On the one hand the participants were asked after completing the first test assignment to answer questions about the assignment and about their motivation during the work on the test. On the other hand the comparison between the first and the second assignment in terms of result and working time allows to make inferences with regard to the course of motivation during the test.

The general interest of the students and trainees in the COMET test assignments is diverse. In the case of electronics technicians for process engineering half of the participants (55%) found the first test assignment interesting or very interesting. The corresponding proportions are slightly higher among the electronics technicians for power engineering and building systems (60%) and the students at technical colleges (61%).

There is a weak but significant statistical relationship between the interest of the participants and the final score achieved at the first assignment ($r = .14$), i.e. higher interest is one factor (amongst others) for a better test result.

On the whole, all test groups tended to work on the first assignment in a concentrated (73%) and careful manner (65%). A striking contrast is that every second electronics technician for process engineering indicates to have been less motivated on the second assignment than on the first; among the electronics technicians for power engineering and building systems as well as among the students at technical colleges only one out of five is saying so.

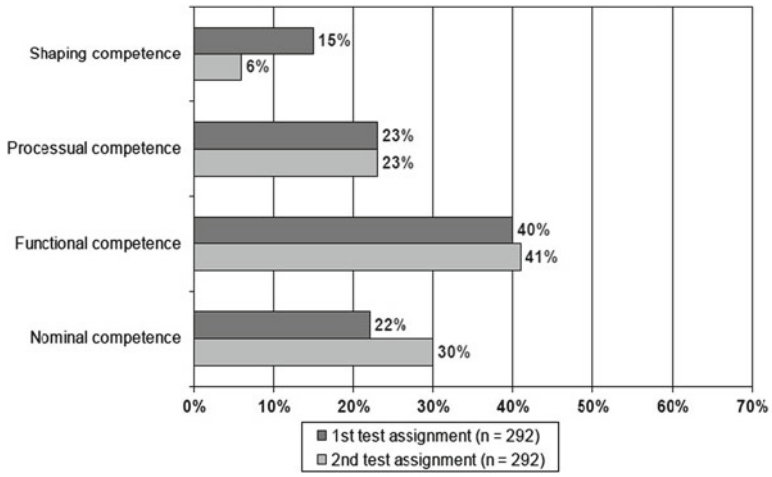

Fig. 8.11 Distribution of competence levels for process engineering trainees in Hessen (comparison of the two test assignments)

The comparison of the results of the two assignments makes it possible to find out whether and in which test groups there are significant differences between the first and the second test assignment. If the score for the second assignment is lower this can be interpreted as an indicator of a decline in motivation.

According to the results this effect is not the same in all test groups. In the case of the crafts trainees there is no difference between the results achieved at the first and the second assignment. The industry trainees, on the other hand, show a better performance at the first assignment. Whereas the proportion of those who attain the highest competence level is 15% for the first assignment, it is only 6% who do so on the basis of the second assignment (Fig. 8.11). A similar effect can be observed with regard to the students at technical colleges: At the first assignment the proportion of at-risk students is 10% while at the second assignment it is 23% (Fig. 8.12).

Moreover, the analysis of the working time makes it possible to estimate how strongly the motivation declines in the course of the testing period. On average the participants worked 100 min on the first test assignment and only 83 min on the second. This can be interpreted as a sign of fatigue.

However, a shorter working time spent on the second test assignment cannot exclusively be attributed to a lack of motivation from the very beginning of the test. It must be taken into account as well that participant might finish the test early when the assignment is too demanding. This, however, would not be in line with the fact that there is no strong correlation between the test result and the working time.

Two observations are of particular importance:

1. The insufficient integration of the COMET test into the feedback structure of 'normal' school instruction has the consequence that the trainees (on average) show little commitment when working on the test assignments. The participants receive feedback on their performance in the test. But they are aware that the test results are

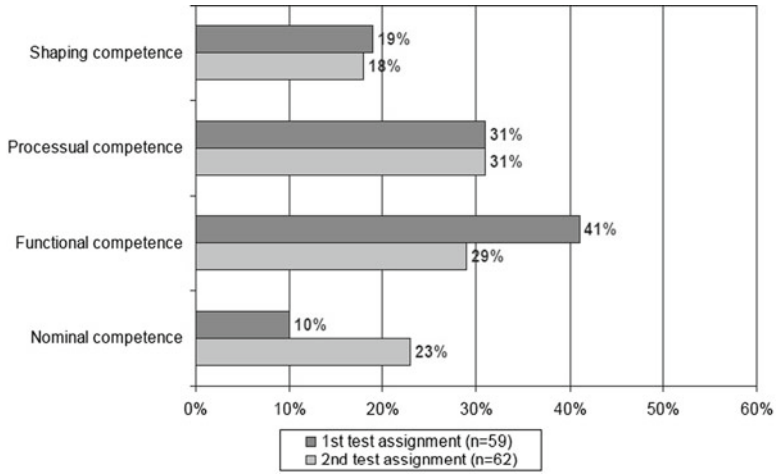

Fig. 8.12 Distribution of competence levels for students at technical colleges in Hessen (comparison of the two test assignments)

not relevant for their grades. The high interest in the test results shows that there is in principle a demand for feedback. However, as long as this methodology of competence diagnostics is not used as a tool for guidance and systematically integrated into a new feedback culture the motivation of trainees in the test is likely to remain low. Some of the findings suggest that the interest in this type of competence diagnostics is rising when the participants experience the methodology as an evaluation tool that allows for the improvement of training quality.

2. Among the majority of participants the motivation declines when they work on the second test assignment. This suggests that future standardized procedures of large-scale competence diagnostics should use only one complex test assignment.

References

KMK-Kultusministerkonferenz (Sekretariat der Ständigen Konferenz der Kultusminis-ter der Länder in der Bundesrepublik Deutschland). (2002). *Qualitätssicherung in Schulen im Rahmen von nationalen und internationalen Leistungsvergleichen – Entwicklung Bildungsstandards*. Beschluss vom 17./18.10.2002. Internetquelle: http://www.kmk.org/fileadmin/pdf/PresseUndAktuelles/2003/Jahresbericht2002_3.pdf. Zugriff 30 Apr 2010.

Müskens, W., Tutschner, R., & Wittig, W. (2009). Accreditation of prior learning in the transition from continuing vocational training to higher education in Germany. In R. Tutschner, W. Wittig, & J. Rami (Eds.), *Accreditation of vocational learning outcomes: Perspectives for a European transfer* (pp. S. 75–S. 98). Bremen: ITB.

Rauner, F., & Zhao, Z. (2009). Berufsbildung in China. In Bertelsmann Stiftung (Hg.), *Steuerung der beruflichen Bildung im internationalen Vergleich*. Gütersloh: Verlag Bertelsmann Stiftung.

Zhao, Z. (2003). *Berufspädagogen in China auf dem Weg zur Professionalität. Berufsbildung, Arbeit und Innovation*. Bielefeld: W. Bertelsmann Verlag.

Chapter 9
The COMET Rating Procedure in Practice: Some Conclusions

9.1 Securing Interrater Reliability

9.1.1 Methodological Approach

The quality of a measurement tool for the evaluation of professional competence and competence development depends largely on the question to what extent the ratings of the participants' individual solutions by the evaluators (raters) converge or diverge (interrater reliability).

In order to help the raters develop a common understanding of the expectations towards the solutions of the work assignments, thereby providing a yardstick for their ratings, rater trainings were carried out at the beginning of the COMET study. These courses are an indispensable prerequisite for a sound rating.

For the training of the raters, a course programme of approximately 12 h was developed (see also Sect. 9.3). This programme is focusing on three topics:

1. Evaluation criteria for the rating
2. Test assignments
3. Rating practice on the basis of empirical material

At the beginning, one gives an introduction into the competence model with its evaluation criteria for the description and assessment of professional competence. This 45-min presentation has the aim to contextualize the study within the current discussions in VET research and to clarify the basic conditions of any kind of competence assessment:

– A conceptual framework
– A competence model
– The data collection
– The data analysis

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Especially the evaluation criteria have to be presented in detail. As explained in the previous chapters, each of the eight criteria is operationalized for the rating with a bundle of questions. The rating sheet includes a total of 40 items that are used for the evaluation of a participant's solution. Given that these items are formulated neither in an occupation-specific nor in an assignment-specific way the rater training aims above all to establish a link to the context. Since the instrument is applied in a specific domain, it needs to be clarified how each of the items can be interpreted in the context of the underlying occupational profile and the expectations associated with the test assignments.

The test assignments are the core of the methodology for the evaluation of professional competence development. The rater training does not aim to reach a consensus with the raters on the structure and design of the test assignments. The raters are not the experts for the development of evaluation tasks. Instead, the training aims to prepare them adequately for their role as evaluators of test solutions. The rating of solutions to the test assignments requires a thorough understanding of the occupational profile and the demands posed on the skilled workers by the daily routine of professional work. The test assignments have to be interpreted against this background and to be embedded in the context. There is no specialized preparation of individual raters for the rating of particular subtasks in the set of assignments. Each rater is trained as an evaluator of solutions that come from the entire set; accordingly he or she must be able to carry out ratings of all four test assignments.

In order to familiarize the raters with the handling of the assessment sheet and to achieve a maximum of convergence among the assessments of the single raters, practical exercises with empirical data are carried out. Solutions from participants in the pretests are assessed by the raters individually as well as in group work. In the beginning each rater is confronted individually with a test assignment and the corresponding solutions of three test persons. These solutions have to be evaluated in an independent ad hoc individual rating. The following Table 9.1 illustrates the correspondence of ratings on the basis of the 40 items before the rater training. The comparatively lower reliability score in the rating by rater 3 shows that there is no full consistency throughout all the ratings, which emphasizes the necessity of the rater training.

Subsequent to the independent single rating on an ad hoc basis, the work is continued in groups with four raters each. The group work analyzed the previous single rating. Each of the raters describes his approach to the rating, the interpretation of the items, his expectations towards the solutions and the basis of his individual judgment on a participant's solution. This reflection in the group has the effect that the

Table 9.1 Interrater reliability of an ad hoc rating before the rater training

Rater code	Test assignment	$Finn_{just}$
1	Signals	0.61
2	Drying area	0.56
3	Drying area	0.30

For details concerning the Finn coefficient, see below
Scores from 0.5 onwards are considered satisfactory, scores over 0.7 are regarded as good

judgments of the raters are evened out in a discursive process. So a common level of expectation within the group is developed as a reference for the rating of solutions.

In the next phase of the rater training, the groups present their discussion processes, the problems addressed and their agreements in a plenary session of all raters. This exchange of views leads to a further consolidation and to a common understanding as a basis for the rating.

This three-phase procedure – single rating, reflection in small groups, plenary session – is continued until the four test assignments from the two sets have been fully comprehended by the entire rating team and a practical rating has taken place on the basis of participants' solutions.

Apart from the development of a shared understanding of the raters, the aspect of practical experience with the rating procedure is another outcome of the training that should not be underestimated. A manual was prepared for the rater training by the scientific project group. This manual includes a basic description of the competence model as well as test assignments and empirical material. This manual serves as a reference work and as a working document for the training seminar.

9.1.2 Pre-rating of a Sample of Test Solutions

The recruitment of raters for a project like this is not an easy task. Teachers who are able to work as raters on the basis of an advanced evaluation methodology are scarce in terms of availability. In the pilot phase it was possible to recruit teachers from vocational schools by a reduction of their weekly teaching commitments. Given that the rating of a single solution takes about 15 min working time for the rater, some working days were estimated in total for each of the raters.

In order to provide evidence of interrater reliability on a sound basis, a sample of solutions was drawn beforehand, which was presented to all 18 raters for evaluation. From the set of four test assignments, two solutions to each assignment were used for the rating. Accordingly each of the raters was confronted with eight variant solutions. In total the pre-rating was based on a set of 144 single ratings.

This pre-rating offered the opportunity to improve the correspondence of ratings by further rater trainings if necessary. It is only after a satisfactory level of interrater reliability has been confirmed that the entire data set of the main survey is made accessible for the rating.

As a result of the response format for the evaluation of the test assignments and the number of raters, the Finn coefficient was chosen as criterion for assessing the interrater reliability. Strictly speaking the Finn coefficient is a measure that requires an interval scale and that can be applied only if the data meet the conditions for analyses of variance. The COMET data are rating data on an ordinal scale, but under the conditions of equidistant distinctions of the characteristics and thus equidistant differences a rating scale might be treated like an interval scale. Moreover, Bortz and Döring (2002, 180f.) point out that the mathematical preconditions of analysis of variance give no information about the measurement level of the data.

Therefore parametric techniques can be applied also in cases where the data are not exactly on an interval scale, provided that the other conditions for the implementation of the procedure are fulfilled.

The conditions for the applicability of the analysis of variance are above all the criteria of (a) independence of observations (orthogonality), (b) normal distribution of observations (normality) and (c) homogeneity of variances (homoscedasticity). A violation of the independence criterion has severe effects whereas the procedure is less affected by violations of the criteria of normality or homogeneity of variances.

The independence of observations is realized in the case at hand. The vocational schools are only the functional units that make it possible to test all students together. The development of professional and practical competences, on the other hand, takes place predominantly in the training enterprise so that due to the affiliation of the students with different enterprises there is independence of observations. Moreover, the vocational students in the different classes work individually on their test assignments and all four assignments are evenly distributed among within each of the classes, which prevents attempts to collaboration or plagiarizing. The evaluation of the solutions by the raters also takes place independently. During the rating procedure there is no communication between the raters.

An explorative data analysis also showed that 33 out of the 40 items fulfill the criterion of homogeneity of variance. The other seven (heteroscedastic) items were nevertheless included in the main survey. However, after completion of the data set these items were again critically tested with regard to their homogeneity of variance before further analyses were carried out. The interrater reliability was calculated under inclusion as well as under exclusion of these seven items.

Empirical data can be tested for normality by means of graphic (e.g. histograms, P-P plots) and statistical (e.g. Shapiro-Wilk test, Kolmogorov-Smirnov Test) methods. In the present study, so-called P-P plots were generated. These represent the expected cumulated frequencies against the real cumulated frequencies. The likelihood of normality was calculated according to Bloom's technique. The following Fig. 9.1 gives an example of the P-P plots generated this way.

While the P-P plots suggest a normal distribution of the data, the normality could not be confirmed by statistical analyses. Given the robustness of the analysis of variance with regard to a violation of the normality criterion it was nevertheless decided not to abandon the Finn coefficient as a measure of interrater reliability.

With regard to the Finn coefficient it has to be observed that this measure is usually considered as not very strict. There is some danger that the reliability indicated by this coefficient overestimates the real agreement between the raters. Accordingly the calculation of intra-class correlation (ICC), being a more rigorous procedure, was taken into consideration as well as an indicator of interrater reliability. However, the problem here is that already a small variance of the item means has the consequence that "no or no significant reliability" (Wirtz and Caspar 2002, 161) can be measured with the ICC. Even though in this case a smaller ICC value is considered acceptable, it is difficult to determine the exact boundary between satisfactory and insufficient interrater reliability. Compared to the ICC, the Finn coefficient is "obviously independent of the variance of item means" (Asendorpf and Wallbott 1979, 245). In the case

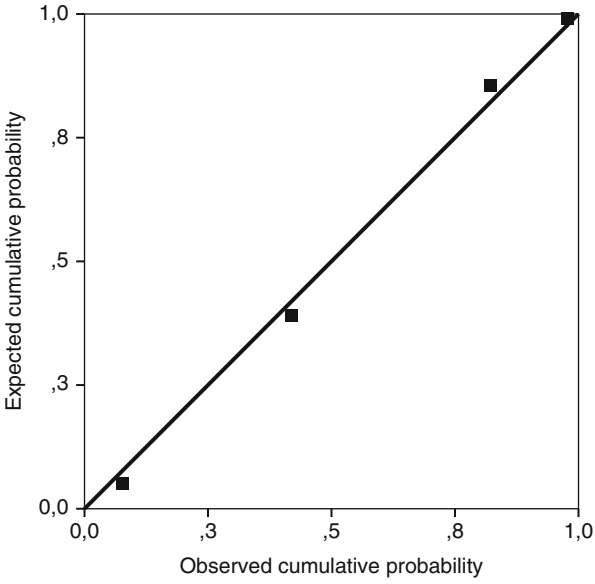

Fig. 9.1 P-P plot for the ratings on the item "Is the proposed solution workable?"

at hand the variances of item means turned out to be low to very low. Their range is between .00 and 1.02. The average dispersion is .37. Therefore the Finn coefficient is applicable as a reliability measure.

There are several models for the calculation of reliability by means of the Finn coefficient. Given that in the present case

1. *Each* participant is assessed on the basis of 40 items and
2. *Each* of the raters carries out these assessments so that raters are not selected at random from a larger population of raters,

A bifactorial model of reliability measurement (rater fixed) is selected (cf. Shrout and Fleiss 1979). In addition it has to be decided whether an adjusted or a non-adjusted reliability is to be used. The *non-adjusted reliability* expresses the degree of agreement between the raters while in the case of the *adjusted reliability* the mean differences between the raters, which could be a distorting factor, are excluded so that the personal 'reference framework' of the raters is not taken into account. According to Wirtz and Caspar (2002), who refer to the ICC, and Shrout and Fleiss (1979), a criterion for making the choice between non-adjusted and adjusted reliability lies in the characteristics of the rater sample. As *all* raters have to assess *all* test persons and the reliability statement applies only to the raters in the pre-rating sample, an adjusted value can be used in the case at hand.

A reliable rating is to be assumed when the differences between the test persons (i.e. the VET students/trainees) are relatively big and the variance between the observers with regard to the test persons is relatively small. The Finn coefficient can have a value between 0 and 1.0. A value of 0.0 means that there is no connection between the judgments of the raters while a value of 1.0 means that there are equal

Table 9.2 Interrater reliabilities of the pre-rating sample from the survey population

		All 40 items	Exclusion of the 7 heteroscedastic items
Participant code	Test assignment	$Finn_{just}$	$Finn_{just}$
H0102		0.70	0.71
H0265		0.76	0.75
H0225	Signals	0.80	0.79
H0282	Signals	0.78	0.78
H0176	Drying area	0.74	0.74
H0234	Drying area	0.71	0.71
H0336		0.87	0.86
H0047		0.73	0.73

means as well as equal variances between the raters. The closer the value is to the maximum of 1.0, the higher is the reliability of the ratings. In the case of the Finn coefficient, values between .5 and .7 can be regarded as satisfactory and values over .7 as good. Given the low rigor of the coefficient, the present study considers only such values as acceptable that represent a high interrater reliability, i.e. only Finn values of at least .7 are regarded as sufficient.

The following Table 9.2 shows the results of the reliability test concerning the eight sample solutions that were presented to the 18 raters after the rater training.

It turns out that the Finn coefficients, without exception, are within the range of high reliability, i.e. the critical value of .7 that was defined for this study is always reached or exceeded. Even when the seven heteroscedastic items are excluded from the calculation the results turn out to be stable. On the whole the interrater reliabilities can be regarded as satisfactory.

9.2 Effectiveness of the Rater Training Concept

In the course of the COMET project there has been a lot of experience with the rater training and the interrater reliability expressed by the Finn coefficient. In the following we will discuss the reliability values that were achieved before and after the rater training as well as the question as to whether a refreshment course is required for the raters after 1 or 2 years of rating practice.

As outlined in Sect. 9.1 the interrater reliability in terms of the Finn coefficient achieved by the German raters in their ad hoc rating before the rater training varies between .30 and .61. These figures do not differ much from the score of the Chinese raters in their first sample rating ($Finn_{just}$ = .41, see Table 9.6 below). After the training of the German raters it was possible to reach Finn coefficients between .70 and .87 on the basis of a rating of all 40 items (cf. Table 9.2 above). This means that the above-mentioned training concept that was applied in the training of the German raters allowed for a considerable improvement of the interrater reliability. The effec-

Table 9.3 Programme for the training of raters

Programme	Time amount
1. Introduction (plenary session) COMET competence model COMET assessment model Items of the rating scale	3–5 h depending on the prior knowledge of the participants
2. Preparation of a sample rating on the basis of selected solutions to all four test assignments with the following steps: Presentation of the first test assignment and the solution space Presentation of the solutions to be rated	30–60 min (plenary)
3. Setting up of work groups of 5–6 persons (random selection); sample rating in the work groups with the following steps: Each of the raters carries out an individual rating. The outcomes of the ratings are compared within the groups. Differences are analyzed. A group rating is carried out. Difficulties in finding a consensus are documented in a short summary. The results of the rating (individual and group ratings) are entered into the laptop for the plenary.	1.5–2 h
4. Plenary session Presentation of the rating results of the different groups, and of the difficulties encountered Comparison of all rating results with the rating by experienced raters, analysis of extreme scores (on single items or by single raters) Presentation of the second test assignment and the two solutions to be rated	1–2 h
5. Rating in groups (same procedure as for the first assignment)	1–1.5 h
6. Presentation and analysis of the rating outcomes in the plenary session	1–2 h
7. Rating of the third and fourth test assignment according to the procedure described above	Approximately 2–3 h for each test assignment
8. Final individual rating of all solutions	Approximately 15–20 min for each solution

tiveness of the training concept in terms of the development of rater competence can be illustrated further by the experience gained with the rater training of the Chinese raters.

The training of the 35 Chinese raters for the COMET Beijing project could build on the experience of the training sessions in Germany. In what follows the course of the training of raters is described in detail. Afterwards the results are analyzed (Table 9.3).

The training of raters at the Institute for Vocational Education at the Academy of Educational Sciences in Beijing from 17th to 19th April 2009 followed the structure of the training for the German raters. For the workshop the relevant manual was translated into Chinese. The manual includes

1. A summary of the COMET competence model and the assessment model
2. The four test tasks as well as the descriptions of the solution spaces
3. Two students' solutions for each of the four assignments, which had also been used for the training of raters in Germany
4. The list of items for the rating of the solutions (rating scale)

The translation of the test tasks, the solution spaces and exemplary solutions was unproblematic because the test tasks are derived from professional work tasks that represent international standards of professional practice. What had to be observed were differences concerning technical norms and regulations for the installation and operation of electrical equipment. Cultural differences, on the other hand, do not play any considerable role in this domain of technology and professional work.

In the course of the December 2008 inception seminar, the curricular and professional validity of the four test assignments was discussed with a work group of teachers and trainers in the field of electrical engineering and electronics. Three of the four tasks were considered valid without much need for further discussion. One task, on the contrary, gave rise to a longer discussion because the situational description, from the Chinese teachers' point of view, included an element that was "alien" to the professional context. It referred to the thermal isolation of a room where an electric radiator was to be installed. An explanation of the task with explicit reference to the competence model eventually led to the approval of this assignment. This event confirms the hypothesis that in the context of school-based vocational education and training the perspective of vocational *subjects* is given priority over the *occupational* perspective. The integration of the concept of learning areas into this discussion made it easier to overcome these differences, which in most cases turned out to be pseudo-problems when viewed under the aspect of work and business process orientation.

The competence model and the rating scale derived from it found widespread acceptance among the teachers as well as by the representatives of the VET administration and the VET researchers. This reaction, which at first sight seems surprising, can be explained by the fact that the organization of curricula according to developmental logic as well as the concepts of work process knowledge and shaping-oriented vocational education have in the meantime become a commonplace also in the continuing education of Chinese VET teachers. Relevant literature from Germany was translated, and multipliers for the development of vocational curricula were educated in an Asia Link project.[1]

[1] URL: http://www.itb.uni-bremen.de/dccd/

The training of raters is organized in such a way that raters are familiarized incrementally with the standardized rating of solutions for each assignment on the basis of solution spaces and with the help of a list of items that operationalize the competence criteria. It is crucial for the acquisition of rater competence that the individual ratings are compared for each item and that deviations are analyzed. This procedure is followed by a group rating in which the group members are required to reach a consensus on each item. The difficulties that are encountered here are documented in a brief summary. If necessary, a rating of another solution is carried out afterwards. This type of group work allows for the development of a shared understanding of the items and their application in the rating of solutions.

The plenary sessions have the aim to analyze differences between the group ratings from the very start in order to achieve a high interrater reliability. The presentation of the rating data and their statistical analysis (Fig. 9.2) is crucial because the individual rating behavior becomes transparent in the context of all raters. The display of the average rating scores for each item as well as of the average score among qualified raters serves as a benchmark that helps to identify deviations and to correct these in the course of the rating.

The final rating of all assignments on the basis of the acquired rater competence has the objective

1. To determine the level of interrater reliability
2. To give the raters feedback on their rating behavior in comparison to other raters and about whether there are still remarkable deviations (which happens only in exceptional cases as the available experience shows)
3. To compare the rating quality with the quality achieved by other groups of raters (e.g., in the sense of an interrater reliability that must be attained in international projects as well)

The rating results for the two solutions (test task "signals") showed a significant deviation of the Chinese raters from the ratings carried out by the German raters. In the case of the first solution the ratings were on average 0.43 points better than the ratings in Germany. The group rating of the first student solution led to insights concerning highly deviant ratings by individual raters or on specific items already in the first plenary session. These insights had an impact on the rating of the second solution where the rater coefficient was slightly higher. When the teachers rated the two solutions for the first test assignments, the majority immediately turned to the rating without considering the solution space beforehand, thereby ignoring the recommendation given in the introductory plenary session. The reason for this behavior was that most of the participants had already taken part in the "teachers' test" and were thus familiar with the test assignments. As a consequence their own test behavior was implicitly adopted as the standard according to which the student solutions were rated. The solution space was seen as an unnecessary means of support and largely neglected. The rating by these teachers was accordingly based on their own subjective and individual professional competence and corresponding expectations with regard to appropriate solutions. It is no surprise that these expectations do not differ much from those of their trainees or students. The outcome was that

	Dachfenster		直观性/展示					功能性				
编码 code	任务 Task	评分人 Name of	1	2	3	4	5	6	7	8	9	10
H0265	天窗控制	Rater 9	2	2	2	1	1	1	1	0	0	1
H0265	天窗控制	Rater 2	1	1	1	1	1	2	2	1	0	1
H0265	天窗控制	Rater 7	1	1	1	1	1	1	1	2	1	1
H0265	天窗控制	Rater 8	2	1	2	1	1	2	1	1	0	1
H0265	天窗控制	Rater 10	2	1	1	1	1	1	1	1	0	1
H0265	天窗控制	Rater 14	1	2	2	1	2	2	2	1	1	1
H0265	天窗控制	Rater 5	1	2	2	1	1	2	1	1	0	1
H0265	天窗控制	Rater 6	1	1	2	2	1	2	1	1	0	1
H0265	天窗控制	Rater 4	2	2	2	1	1	2	2	1	2	2
H0265	天窗控制	Rater 3	2	2	2	2	1	2	2	1	0	2
H0265	天窗控制	Rater 12	1	1	1	1	0	1	1	1	0	1
H0265	天窗控制	Rater 13	2	2	1	1	1	2	1	2	1	2
H0265	天窗控制	Rater 17	2	1	1	1	1	1	1	1	0	1
H0265	天窗控制	Rater 18	0	1	2	1	1	1	1	1	1	1
H0265	天窗控制	Rater 19	1	1	1	1	1	1	1	0	1	2
H0265	天窗控制	Rater 21	1	1	1	1	1	1	1	1	0	1
H0265	天窗控制	Rater 16	2	2	2	1	2	2	2	2	0	2
H0265	天窗控制	Rater 22	2	2	2	2	2	1	2	2	1	1
H0265	天窗控制	Rater 11	1	1	1	1	1	1	1	0	0	1
H0265	天窗控制	Rater 15	2	2	2	1	2	1	2	2	1	1
H0265	天窗控制	Rater 20	1	1	1	1	1	1	0	0	0	1
			1	2	3	4	5	6	7	8	9	10
H0265	天窗控制	China AVA	1,4	1,4	1,5	1,1	1,1	1,4	1,3	1	0,4	1,2
H0265	天窗控制	German AVA	1,1	1,4	1,5	1,7	1,2	1,4	1,7	1,2	1,2	1,4
			1	2	3	4	5	6	7	8	9	10
H0265	天窗控制	Group1	2	2	2	1	1	2	2	1	0	1
H0265	天窗控制	Group2	2	1	2	1	1	1	1	1	0	1
H0265	天窗控制	Group3	1	1	1	1	1	1	1	1	0	1
H0265	天窗控制	Group4	2	2	2	1	2	2	2	2	1	1
H0265	天窗控制	max	2	2	2	1	2	2	2	2	1	1
H0265	天窗控制	min	1	1	1	1	1	1	1	1	0	1
H0265	天窗控制	avg	1,8	1,5	1,8	1	1,3	1,5	1,5	1,3	0,3	1

Fig. 9.2 Example of the presentation of rating data in the plenary session

the overall ratings were relatively positive. In the teachers' implicit competence model professional competence is for the most part reduced to decontextualized subject-specific knowledge. When the results of the individual and group ratings were analyzed in the plenary session, the rating behavior and its motives were also examined by the participants. The analysis was concluded with the agreement to use the solution spaces developed for each of the test assignments.

Table 9.4 Results of the interrater reliability test

		Day 1	Day 2 a.m.	Day 2 p.m.	Day 3 a.m.	Day 3 a.m.
Participant code	Test assignment	$Finn_{just}$				
H0282	Signals	.41				.82
H0225	Signals	.54				.79
H0176	Drying area		.80			.84
H0234	Drying area		.75			.80
H0265				.84		.82
H0102				.82		.83
H0336					.86	.85
H0047					.79	.79

The rating of the solutions for the second test assignment remarkably differed from the first rating round. On the whole the participants were concentrated and the rule not to communicate with other raters during the individual rating was observed. All raters first checked the solution space before the rating and also occasionally referred to it during the rating. The presentation of the results including the comparison with the results of the German raters was a surprise, for the marks of the Chinese raters were now considerably lower, that is, the Chinese raters were now more critical than their German colleagues. At the same time the degree of correspondence in the rating (the interrater coefficient) increased. After the second round the interrater reliability reached a score of .80 for the first and .75 for the second solution (see Table 9.4 below). What had to be examined in the plenary session was the phenomenon of the overly critical rating compared to the rating by experienced raters.

The reason that was identified was a misunderstanding which prompted the majority of participants to regard the solution space as an ideal and maximum solution. The statement of one of the participants that "the solution space tempts the user to expect all aspects of the solution that are described therein" was confirmed by many participants. The possibility that the solution space might be used as a reference system and a standard for the evaluation of solutions had emerged implicitly as there had been no explicit warning against this misunderstanding during the introduction of the rating procedure. It might also be the case that the translation of the text contributed to a somewhat vague description of the solution space and its function.

As was to be expected, the rating behavior became more professional during the rating of the third test assignment. The high interrater reliability shows that all participants achieved the goal of applying the objective and standardized rating procedure instead of their own subjective standards.

The final rating of all test assignments on the third day had the objective to stabilize the rater competence that had been trained. The results confirm the competence development of the raters and the stabilization of their competence at a high level. The effectiveness of the rater training concept is also confirmed by the fact that participants who were unable to attend some of the group exercises had more difficulties with the rating procedure.

9.3 Empirical Quality of the Competence Model and the Rating Procedure

When the 2008 tests were completed, there were two rating sheets for each of the participants in the student samples in Bremen and Hessen. The raw data of these ratings were transformed into a single data matrix. Where two ratings differed from each other the means were entered. This led to means between 0 and 3. In some cases means with two digits after the decimal point were calculated, which were subsequently transformed back into a four-point scale:

- 0 – 0.49 = 0
- 0.50 – 1.49 = 1
- 1.50 – 2.49 = 2
- 2.50 – 3 = 3

Cases where it was not clear to whom of the participants a particular rating belonged were excluded. The final matrix included 1,222 cases, of which 714 were from the Hessen sample and 508 from the Bremen sample.

With regard to the further analysis of the data by means of the software WinMira (calculation of Rasch models, latent class analyses) it is desirable that each evaluation category is represented by at least 10 ratings. The frequencies of the 40 items show that 13 items did not meet this condition. Therefore in the structural analysis of the data from the pilot phase the categories "requirements are mostly fulfilled" and "requirements are completely fulfilled" were merged so that the resulting rating scale includes only three levels:

- 0 = requirements are not at all fulfilled
- 1 = requirements are not fulfilled for the most part
- 2 = requirements are mostly or completely fulfilled

In the case of item 20 ("To what extent are not only business aspects taken into account, but also economic and social aspects of efficiency?"), the critical value of 10 ratings could not be reached so that this item was ultimately excluded from the subsequent analyses. Item 20, which has to be allocated to the level of "processual competence", turned out to be the most difficult item during the pilot phase. It is unclear whether this is due to the real difficulty of the task or an effect of the formulation or the rater training. The teachers involved confirmed that they had problems with this item, too. It was therefore excluded from the following phases of the COMET survey.

In order to get an overview of the quality of the rating data, some classic analysis techniques were applied in the first step. The question as to whether the 40 items could be reduced to the eight competence criteria of the COMET model was addressed first by means of an explorative factor analysis. Factors were extracted by means of principal components analysis and VARIMAX rotation. The Kaiser-Guttman criterion (eigenvalue > 1) was used as benchmark for the extraction of factors.

The factor analysis leads to a 6-factor solution with an explained variance of 64.6 %, which can be regarded as satisfactory. The groups of five items that each were supposed to refer to the competence criteria

– Work and business process orientation
– Social compatibility
– Environmental compatibility
– Creativitycould each be associated with one of five factors.

The items that were supposed to belong to the underpinning competence dimensions of

– Clearness/presentation
– Functionality
– Are loading on one common factor. In addition, two items of the criterion "utility" (items 11 and 12) and one item of the criterion "economy" (item 16) are loading on this factor.

Given that the two criteria "clearness/presentation" and "functionality" are associated with the hypothesis that these two criteria together define the level of functional competence, their loading on one common factor is consistent with the prior assumptions.

To summarize, the results of the factor analysis correspond to a large extent to the theoretical assumptions. Although a representation of the rating items by the eight dimensions of the rating sheet cannot be fully realized, it can be shown that the criteria of "clearness/presentation" and "functionality" express the level of functional competence while the criteria of "utility" and "economy" represent the level of processual competence.

The analysis of the rating sheets showed that items 11 and 12 might have been confused in the rating process with similar items from the area of "functionality" (items 6–10). Therefore the items 11 and 12 changed places with items 14 and 15 for the test dates after the pilot phase.

It was an objective during the further analyses of the data to maintain the framework of the eight criteria and the competence levels. Therefore reliability analyses of the items corresponding to each of the criteria were carried out in order to test whether it made sense to continue with the combined analysis of items by groups of five according to the competence criteria. The reliability analyses delivered the Alpha values presented in the Table 9.5 below.

In the case of the criterion of "economy" the Alpha value is slightly reduced to .80 when item 20, which does not meet the requirement of a minimum of 10 ratings, is excluded from the scale. On the other hand, excluding item 35 from the "environmental compatibility" scale would lead to a minor improvement of the Alpha value up to .86.

In the following step the reliability values for the competence levels "functional competence", "processual competence" and "shaping competence" were tested. It was also investigated whether all 40 items together constituted the overarching theoretical construct of "professional competence". The results are presented in Table 9.6.

On the whole the results of the reliability tests demonstrate a quite satisfactory stability of scales for each of the eight criteria that specify the three levels of the

Table 9.5 Reliability test for the eight criteria of the rating sheet

Competence criterion	Rating items	Alpha
Clearness/presentation	1–5	.88
Functionality	6–10	.86
Utility	11–15	.84
Economy	16–20	.82
Work and business process orientation	21–25	.87
Social compatibility	26–30	.84
Environmental compatibility	31–35	.85
Creativity	36–40	.90

Table 9.6 Reliability test for the three competence levels

Competence level	Competence dimensions	Alpha
Functional competence	Clearness/presentation Functionality	.93
Processual competence	Utility Economy Work and business process orientation	.92
Shaping competence	Social compatibility Environmental compatibility Creativity	.93
Professional competence	All 40 items	.97

competence model. The reliability scores for the theory-based competence levels and for the overall construct of professional competence turn out to be very high.

In the discussions of the COMET project coordination groups (Bremen, Hessen, Beijing) on the question whether and to what extent participants should be informed about their test results one of the issues were the differences between the judgments of individual raters. It could not be ruled out that after a repeated participation as rater (in the course of longitudinal studies) or following the establishment of a large-scale competence diagnostics individual rating patterns might emerge. The alternative hypothesis would be that raters become more competent in the application of the rating procedure when they gain practical experience so that the achieved level of interrater reliability would be maintained. In order to test this alternative hypothesis an additional training seminar was held in 2009 for raters that had already taken part in the 2008 rating. The results of the rater training in Beijing suggested that for such a refreshment course two sample ratings would be sufficient. The outcomes of two refreshment trainings (Beijing and Hessen) support the view that once it has been attained, the level of rater competence according to the COMET rating procedure is preserved when there is the opportunity to participate in ratings on a regular basis (e.g. once a year).

Conclusion: In the first sample rating during the rater training there is the tendency to give marks that are too "good" because the raters typically start analyzing the solution of the test assignment without considering the solution space first.

Accordingly their own expectations and attitudes towards problem solving, which are influenced by their teaching and training practice, had a dominant role in the rating process. These subjective expectations do not differ much from those of the trainees and students. The rating items and the corresponding solution spaces are the crucial element that allows for the objectivity of the procedure. Another aspect of the rater training is that the results vary strongly in the beginning because a shared understanding of the rating system emerges only after a reflection of one's own ratings in comparison with the judgments of the other raters.

Confronting the raters with their relatively high and usually quite diverse initial rating scores and comparing the latter with the judgments of qualified raters (in the sense of a reference system) prompts the raters to realize that the rating system requires a thorough reflection of the test assignments and a consideration of the solution spaces. This way the subjective expectations of teachers and trainers are replaced by a standardized rating procedure.

When another two test assignments are rated, the correspondence between the rating results increases significantly. The example of the rating in Beijing shows that at this stage the rating had become more critical than in the first round or in the reference group. The table shows that the more critical assessment was due to the limited number of items. As explained above, the solution space was interpreted as an exhaustive description of solutions, which implied the misconception that the solution space was an ideal description of a complete solution. This misunderstanding could be clarified in the course of the rater training.

As the sample rating proceeds, a professional rating behavior with a high inter-rater reliability emerges. Four sample ratings can be sufficient for the attainment of a high interrater reliability. The number of sample ratings scheduled for the Chinese raters was twice as high because the prevalent opinion in the COMET Beijing group was that the differences between the VET systems in Germany and China necessitated a particularly intensive rater training. This expectation was not confirmed. It was already after four sample ratings that the Chinese raters also realized the high interrater reliability that was desired.

The statistical analysis of the rating results immediately after the group exercises proved to be necessary because the tables made it possible to analyze the individual rating behavior in detail. The opportunity for each rater to draw comparisons with the results of other raters is very interesting for the participants and leads to a considerable improvement of the quality of rating results in the course of further sample ratings. The discussion in the work groups as well as in the plenary session also contributes to a successful implementation of the rater training.

9.4 The Test Tasks as Learning Tasks

As this book deals with COMET as a project of competence diagnostic, we can only give a cursory glance to one of its most important practical aspects: The test tasks' use as learning tasks. The competence model allows the construction of tasks that contain important aspects of professional work. As we showed in Sect. 3.3.3, the content and action dimension of the model conscribe the space of a holistic solution

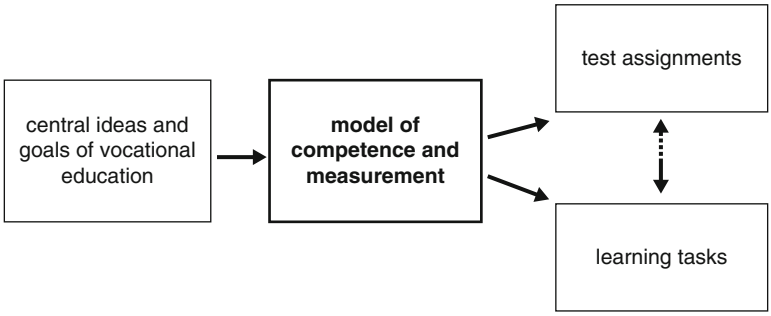

Fig. 9.3 From the guiding principles and objectives of vocational education and training to the construction of learning tasks

of work tasks. This makes the model a perfect starting point for the construction of learning tasks (Fig. 9.3).

Used at VET schools, such open test assignments (see Chap. 5) have the potential to bridge the gap between school-based, often subject-specific learning and the acquisition of professional competences necessary in the world of work.

The group of teachers working at COMET Hessen developed a number of such tasks that are available at http://www.berufliche.bildung.hessen.de/komet/aufgaben-konzept/index.html

Katzenmeyer et al. (2009) presented one way of integrating such tasks into teaching. In learning projects, groups of students work out such a task, working through the different steps of a client's order until final delivery. Here, the task is more or less detailed and more or less additional information is given according to the student's level – novices get much more explicit help an technical specifications at hand than advanced students that have to organize the relevant information themselves. Another, equally valid, way would be to develop tasks specifically aimed at novices (see Chap. 2) with the idea to strengthen the students' ability to carry out complex tasks without external guidance from the very beginning.

Evaluation of the students' achievements can be done along the frame of the test tasks' evaluation items, normally amended by additional criteria aiming at the learning process itself. Here, it proved extremely worthwhile to carry out this evaluation as a self-evaluation by the students. Discussing how and why they matched the different criteria – or failed to match them – rose the students' awareness of what vocational education – at school or the workplace – is about: to become an expert in one's profession.

References

Asendorpf, J., & Wallbott, H. G. (1979). Maße der Beobachterübereinstimmung: Ein systematischer Vergleich. *Zeitschrift für Sozialpsychologie, 10*, 243–252.

Bortz, J., & Döring, N. (2002). *Forschungsmethoden und Evaluation*. Berlin: Springer.

Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: Uses in assessing rater reliability. *Psychological Bulletin, 86*(2), 420–428.

Wirtz, M., & Caspar, F. (2002). *Beurteilerübereinstimmung und Beurteilerreliabilität*. Göttingen: Hogrefe.

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