

Definition and Selection of Competencies

## **Concepts of Competence**

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Definition and Selection of Competencies:  
Theoretical and Conceptual Foundations (DeSeCo)

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## Abstract

Competence is a term that is used both scientifically and in everyday language. Underlying a large variety of meanings, it is possible to discern a small semantic core that is captured by the terms “ability”, “aptitude”, “capability”, “competence”, “effectiveness” and “skill”. Competence can be attributed to individuals, social groups or institutions, when they possess or acquire the conditions for achieving specific developmental goals and meeting important demands presented by the external environment. Because schools must educate, teach, and prepare each student for future life tasks, the focus in this report will be on competence as an individual attribute, rather than on the competence of a social group or institution.

A review of the many scientific uses of the terms “competence” and “competencies” shows that they are ascribed a variety of meanings: (a) all performance abilities and skills; (b) only those inherited, domain specific prerequisites necessary for acquiring primary knowledge systems (especially language); (c) learned (demand-specific) knowledge and skills; (d) individual needs for effectiveness; (e) subjective evaluation of the self; and (f) the entire set of cognitive, motivational and social prerequisites for successful action (action competence).

Over the last decades, a great deal of scientific attention has been given to the constructs “key competence” (specialized competencies that can be used to master different demands) and “metacompetence” (knowledge about the availability and use of one's own competencies to optimize learning and problem solving behavior).

Because the scientific definitions of the concept of competence are so heterogeneous, it is impossible to identify a consensually agreed core definition. It is, however, possible to explicate the scientific and practical goals that should be followed with a theoretical construct of competence.

Given the intended use of this report (to provide a conceptual basis for school-based achievement comparisons in international and national systems of reference), it is recommended that competence be considered as a learned, cognitive demand-specific performance disposition, and that corresponding metacompetencies and motivational attributions be included in analyses of this construct.

The social sciences are plagued by the fact that much of their terminology is also used in everyday language. Thus, the same term may have both a precise, scientific meaning, embedded within a theoretical context, and a more variable and vague meaning, stemming from everyday use. This can lead to ambiguity when the vocabularies of everyday language and social science terminology are exchanged and assimilated, which, of course, is the usual case! In disciplines such as psychology and sociology, this has meant that the scientific use of many concepts has become quite unpredictable. Some scientists use particular terms with a narrow, theoretically guided reference, while others use the same terms with an everyday reference. The term “competence” is a good illustration: Its many meanings make any attempt to develop a general theoretical base from which to make pragmatic recommendations quite challenging.

## 1. The goals of this report on concepts of competence

This report has several goals at different levels of abstraction, all of which center on exploring the many theoretical and pragmatic conceptions of competence. To address these goals, it is necessary to consider a variety of aspects of selected theoretical and pragmatic concepts of competence. The report includes:

- An overview of different ways in which competence has been conceptualized and defined (including a glossary of synonyms and similar concepts).
- An overview of the theoretical reference systems underlying different conceptualizations and use of the term “competence” (including consideration of the terms “key competencies” and “metacompetencies”).
- An overview of attempts to categorize conceptual spheres of competence, including identification of components and/or elements used to organize this conceptual network in a theoretical or pragmatic way.
- An overview of the theoretical and practical problems in scientific uses of the concept of “competence”
- Discussion of which theoretical reference systems are pragmatically appropriate and not appropriate for defining and categorizing human competencies that clarifies the utility of (at least) one such reference system as the scientific base for selecting and measuring important competencies in the context of a multinationally organized empirical study on school performance.

## 2. Definitions of the concepts “competence” and “competencies”.

In general, we know what the terms “competence”, “competencies”, “competent behavior” or “competent person” mean, without being able to precisely define or clearly differentiate them. The same can be said for terms such as “ability”, “qualification”, “skill” or “effectiveness”. The use of these terms as synonyms is reflected in dictionary entries, as well. For example, “competence” is defined in Webster's dictionary as “fitness or ability”. Words given as synonyms or related terms are “capability”, “capacity”, “efficiency”, “proficiency” and “skill”.

If one considers the Latin roots and historical variations in meanings ascribed to competence, it also is understood to mean “cognizance” or “responsibility”. This concept of competence has been and is used in a very specific and arbitrary manner in biology, immunology, jurisprudence, and in some other scientific disciplines, which will not be further elaborated in this report.

Restricting our focus to the use of the word ‘competence’ in developmental sciences, psychology, linguistics, sociology, political science and economics still yields a wide variety of definitions. Nonetheless, in all of these disciplines, competence is interpreted as a roughly specialized system of individual and/or collective abilities, proficiencies, or skills that are necessary or sufficient to reach a specific goal. This can be applied to individual dispositions or to the distribution of such dispositions within a social group or an institution (i.e. a business).

Over the last decades, “competence” has become a fashionable (and sometimes even modernistic) term with a vague meaning not only in public use, but also in many

social sciences. One could even refer to a conceptual 'inflation', where the lack of a precise definition is accompanied by considerable surplus meanings.

A typical illustration of this can be found in a report given by an advisory committee for technology and innovation appointed by the German Chancellor. The report states: "Competence can generally be understood as knowledge times experience times power of judgment. Knowledge is the necessary foundation of competence, and experience is the habitual ways one deals with acquired and continuously changing knowledge. Power of judgment is a criterion for the independence of knowledge and its use. Thus, competence is always more than just knowledge or just experience" (BMBF, 1998, p.10). Specific competencies mentioned in this report included: economical, technological, technical and methodological competencies; social competencies; creativity and innovation skills; mobility and flexibility, combined with persistence, reliability and precision.

In some respects this report is typical of many current publications: Although the term "competence" is used to refer both to high-achieving individuals and successful social groups that master specific tasks and reach important goals, it is always concerned with the necessary learning dispositions that are acquired by individuals and/or the members of social groups and that must be used to solve demanding problems.

To summarize, the concept of competence refers to an individually or interindividually available collection of prerequisites for successful action in meaningful task domains. In the following, the individual aspect, which dominates the social and behavioral sciences literature, will be accentuated. An important reason for this focus on the individual perspective is the fact that schools are the primary 'educational settings' over the course of individual development. Each single student must acquire necessary competencies and required education as preparation for his or her later social and professional life.

In this regard, the classroom is fundamentally different from companies, ministries, sport clubs or other similar institutions. Although instruction also fosters the use of social skills, its goal is not the acquisition of role-specific or institution-specific competencies. Rather, such skills are only the means through which education proceeds. Each student must acquire fundamental competencies (general education and literacy, basic technical knowledge and abilities, learning strategies, action control techniques, team skills, etc.). The individual as scientific reference system for the analysis of the acquisition, availability or non-availability and use of competencies corresponds to the individual educational task of the school, which requires that instruction prepare children and adolescents for the variable conditions and tasks of adult life. In comparison, the cultural and social educational tasks of the school correspond more to a collective competence concept (see commentaries on this report from Featherman & Carson, but also Sternberg & Kaufman, 1998; Palincsar, 1998; Foss & Knudsen, 1996). The choice to focus on the individual rather than the collective concept of competence is pragmatic, and implies no evaluation of the two theoretical-conceptual approaches.

The variety of meanings given to the concept of competence is seen not only in its many uses, but also in the construction of compound words to express competence, such as: media competence, business competence, traffic competence, age compe-

tence, and also cognitive, social, motivational, personal, ... etc. competencies. It is not possible to discern or infer a coherent theory out of these many uses. There is no basis for a theoretically grounded definition or classification from the seemingly endless inventory of the ways the term 'competence' is used.

One will be equally disappointed if one restricts the search for a common core to only scientifically based definitions of the concept of competence. There are many different theoretical approaches, but no single common conceptual framework. What follows is a descriptive list of nine different ways in which competence has been defined, described or interpreted theoretically. This includes competence as: (a) general cognitive ability; (b) specialized cognitive skills: (c) competence-performance model: (d) modified competence-performance model: (e) motivated action tendencies: (f) objective and subjective self-concepts: (g) action competence: (h) key competencies: (i) metacompetencies.

#### *(a) General cognitive competencies*

The prototypical approaches that focus on general competencies include psychometric models of human intelligence, information processing models, and the Piagetian model of cognitive structural development. Psychometric approaches understand intelligence (competence) as a system of more or less content- and context-free abilities and aptitudes (Carroll, 1993). They provide the cognitive prerequisites for purposeful action, reasoning, successful learning and effective interaction with the environment. In information-processing approaches, intelligence (or general competence) is understood as an "information processing machine" whose general system features (i.e. processing speed, working memory capacity, processing capacity) allow it to acquire an endless variety of specific knowledge and skills. The Piagetian approach also assumes general cognitive competencies. However, in this view ontological, psycho-logically organized adaptation processes also take a central role. They engender a universal sequence of developmental stages that lead to increasingly flexible and abstract knowledge and action competencies (Piaget, 1947; see also Parrat-Dayana & Tryphon, 1998), which are also adaptations to concrete environmental conditions (Cellerier & Inhelder, 1992).

#### *(b) Specialized cognitive competencies*

A second theoretical approach focuses on the categorization and characterization of specialized, not general cognitive competencies. Specialized cognitive competencies refer to clusters of cognitive prerequisites that must be available for an individual to perform well in a particular content area (e.g., chess playing, piano playing, automobile driving, mathematical problem solving, trouble-shooting in complex systems, etc.). The domains of specialized competencies can be very narrowly defined (e.g., chess competence) or very broadly and openly defined (e.g., diagnostic competencies).

We know, at least in the case of excellent chess players, that neither general memory capacity, extreme intelligence, nor unusual problem solving skills are necessary for high performance. Rather, the cognitive competence of chess masters and club players, in contrast to beginners, stems from a system of specialized skills and rou-

tines, based on thousands of chess configurations stored in memory (“memory chunks”). This is an example of a learned competence, that of course may itself depend on greater or lesser abilities in acquiring this expertise (see Charness, 1991; Gruber, 1991).

Although the surface performance skills and prerequisite competencies for chess are quite different from those for other areas of expertise (e.g., medical diagnosis), the types of necessary underlying cognitive competencies are comparable. For example, in both chess and medical expertise, mental networks of content-specific knowledge, skills and routines are more important than general cognitive abilities. These specialized competencies require long-term learning, broad experience, deep understanding of the topic, and automatic action routines that must be controlled at a high level of awareness (Patel, Kaufman & Magder, 1996).

An overview of research on performance-specific concepts of cognitive competence suggests that this approach has strong advantages over ability-centered definitions of competence because of its theoretical base and pragmatic applications. In particular, the performance-specific approach allows scientific analyses of competence to consider the necessary learning prerequisites for development (Leplat, 1997).

### *(c) The Competence-Performance model*

One of the most influential theoretical paradigms in competence research is derived from a distinction between competence and performance used by the linguist Noam Chomsky (1980). Chomsky understood linguistic competence as a universal, inherited, modularized ability to acquire the mother tongue. A limited system of linguistic principles, abstract rules, and basic cognitive elements (competence) combined with a specific learning process allows each normal human to acquire the mother tongue, including the ability to create and understand an infinite variety of novel, grammatically correct sentences (performance). Linguistic competence thus underlies creative, rule-based language learning and language use.

Chomsky’s linguistic competence model, admired and cited, but also criticized and challenged, is frequently used in the cognitive sciences, especially in psycholinguistics and in cognitive developmental psychology. In addition, many models have incorporated individual components of the competence-performance model, including the ideas of: (I) Domain specificity, (II) an inborn system of modularized principles and rules, (III) Rule-based learning, and (IV) Performance whose quality depends not only on universal principles, but also on learning experiences and the learner’s/actor’s current situational context.

Across linguistics, philosophy, and psycholinguistics, the use of the term ‘competence’ has acquired a range of meanings differing somewhat from Chomsky’s original theoretical meaning, and applied to an expanded set of phenomena. In theories of speech, this broader concept was seen as a semantic and pragmatic change in the definition of linguistic competence, characterized as an integration of psychological, sociological and ethnological approaches with empirical findings (Hymes, 1967). Especially influential examples are theories of communicative competence and communicative acts (Habermas, 1971; 1981; Wunderlich, 1971). In a similar theoretic-



cal context, further variants of the competence concept include hermeneutic-analytical, rhetorical, persuasive, poetic and aesthetic competencies.

Currently, the concept of competence has been expanded even further with concepts such as 'social competence' and 'emotional competence' (Weber & Westmeyer, 1998). In these examples, 'competence' has replaced an earlier, intelligence-based concept (Social intelligence: Cantor & Kihlstrom, 1987: Emotional intelligence, Goleman, 1995). Weber & Westmeyer (1998) suggest using 'social-' or 'emotional competence' rather than 'social-' or 'emotional intelligence' because “..These concepts have... the advantage that assessments can be carried out in a concrete, substantive context and measures can be described, thus allowing statements about what competence is” (p. 4).

Chomsky's basic dual model of linguistic competence and performance has been generalized extensively in modern developmental psychology to characterize the ontogenesis of numerical, spatial, physical, psychological, social psychological and other areas of domain-specific knowledge.

#### *(d) Modifications of the Competence-Performance model*

The competence-performance approach was energized with the postulation of a competence-moderator- performance model (Overton, 1985). In this model, it is assumed that the relation between competence and performance is moderated by other variables, for example, cognitive style, memory capacity, familiarity with the task situation, and other individual difference variables.

Within developmental psychology, another modification of the competence-performance model, even more influential than Overton's moderator model, involved a conceptual differentiation of competence into three components (see Gelman & Meck, 1992; Gelman & Greeno, 1989; Greeno, Riley & Gelman, 1984, and also Sophian, 1997). These three components are:

- Conceptual competence, which refers to Chomskian rule-based, abstract knowledge about an entire domain.
- Procedural competence, which refers to the availability of procedures and skills that are necessary to apply conceptual competence in concrete situations
- Performance competencies, which refer to all those skills required to evaluate the relevant features of a problem, so that suitable solution strategies can be selected and used

Greeno et al.(1984) refer appropriately to the last two components of competence as a “Logic of Planning”.

This last competence-performance model, enriched with a differential psychology perspective, has been criticized for focusing only on cognitive aspects, and not on the socially transmitted, subjective perspective of the actor (Elbers, 1991). Sophian (1997) commented that this model exclusively addresses the influences of competence on performance (behavior), and ignores the shaping of competence through performance.

*(e) Cognitive competence and motivational action tendencies*

The close relation between cognitive competence and motivational action tendencies was 'discovered' by R.H. White in 1959. In an influential article, he defined competence as an "effective interaction (of the individual) with the environment.... I shall argue that it is necessary to make competence a motivational concept, that there is a competence motivation as well as competence in its more familiar sense of achieved capacity" (White, 1959, p.317f).

White postulated an intrinsic need to deal effectively with the environment (see Mac-Turk & Morgan, 1995). This need is characterized by an "effectance motivation" that is closely tied to personal "feelings of efficacy". There are a variety of self-concept models that span the continuum between adopting more cognitive or more motivational definitions of competence. These models concern knowledge and beliefs about one's own learning and performance. An individual's system of knowledge and beliefs is formed through experience with one's own competence in achievement situations, and influences performance and achievement through expectations, attitudes and interpretative schemata. For all models of the self-concept, it is important to separate concepts at the trait level (personal self-concept as a stable, relatively persistent belief-value system) and the state level (current task-specific self-concept).

Hierarchical models of the self-concept (e.g., Epstein, 1973) differentiate the concept according to levels of generality. The top level is a highly generalized, overall self-concept (e.g., "a highly self-confident person"). The next level concerns self-evaluation in different, but still general areas (e.g., self-concepts of physical attractiveness, social standing, personal achievement, morality). Lower levels include further differentiations. For example, the self-concept of achievement is comprised of more specific self-concepts for different performance domains such as mathematics, foreign languages, sports, rhetoric, and so on. Subordinate to these are yet more finely differentiated self-evaluations for specific competencies within a performance domain (e.g., arithmetic versus geometry versus calculus in the mathematics domain, persuasive rhetoric versus story telling versus public speaking in the speech domain).

In addition to the self-concept, an especially influential theoretical construct for describing subjective experience of personal competence, there are two other constructs that are relevant to the analysis of competencies and competence use. These are the achievement motive and personal control beliefs. Important features of achievement motivation include the strength, direction and origins of an individual need to experience competence through excellent performance. This need can be inferred from hope of success or fear of failure, and from intrinsically or extrinsically caused motivational states. Stable personal control beliefs include the extent to which the self is experienced as the cause of actions and action results, and attributional style -- the personal explanations for success and failure.

These aspects -- the self-concept, achievement motive, and personal control beliefs, complement a concept of competence based on objective performance criteria with dimensions based on subjective experience and attitudes about learning and performance.

*(f) Objective and subjective competence concepts*

Analogous to the general differentiation of competence into cognitive and motivational aspects, Sembill (1992) distinguished between objective competence (performance and performance dispositions that can be measured with standardized scales and tests) and subjective competence (subjective assessment of performance-relevant abilities and skills needed to master tasks and solve problems; for a comprehensive overview see Sternberg & Kolligian, Jr., 1990).

Subjective competence can be further differentiated into three components (Stäudel, 1987):

- Heuristic competence (generalized expectancy system concerning the effectiveness of one's abilities across different situations – generalized self concept);
- Epistemological competence (beliefs and confidence that one possesses domain specific skills and knowledge to master tasks and problems within a specific content domain - domain specific self-concept).
- Actualized competence (momentary subjective self-confidence that one possesses the abilities, knowledge and skills believed necessary for success in a concrete learning or performance situation -- current or dynamic actualized self-concept).

*(g) Action competence*

Unlike concepts of competence, that accentuate either cognitive or motivational aspects, action competence includes all those cognitive, motivational and social prerequisites necessary and/or available for successful learning and action. The concept of action competence has been applied especially in the analysis of the necessary and sufficient conditions for success in meeting task, goal and success criteria in selected fields of action (e.g., profession, institution, or social group). The following components are frequently included in action competence models:

- General problem-solving competence
- Critical thinking skills
- Domain-general and domain-specific knowledge
- Realistic, positive self confidence
- Social competencies

The theoretical construct of action competence comprehensively combines those intellectual abilities, content-specific knowledge, cognitive skills, domain-specific strategies, routines and subroutines, motivational tendencies, volitional control systems, personal value orientations, and social behaviors into a complex system. Together, this system specifies the prerequisites required to fulfill the demands of a particular professional position, social role, or personal project (Boyatzis, 1982; Lévy-Leboyer, 1996).

In this theoretical perspective, the concept of action competence is not applied only (or primarily) to an individual's psychological prerequisites, but rather to the complementary performance dispositions across different individuals that are necessary for a group or an institution to function successfully. In addition to the cognitive and motivational components necessary for solving tasks and reaching goals, these models include other individually and collectively available skills, such as:

- nonspecific vocational competencies (e.g., literacy, see OECD, 1996; critical thinking abilities, see Halpern, 1998)
- Specific vocational competencies (examples from the most frequently cited competencies for successful teaching: factual knowledge, classroom management competencies, diagnostic competencies, and didactic competencies).
- Institutional-specific competencies (for example, for teachers: social behavior with colleagues, parents and school administration; institutional engagement; identification with the institution, and so on).

Thus, in this approach, competence is understood less as the psychological prerequisites for successful individual action and more as the individual, role-specific and collective conditions underlying the successful development of cultures, institutions and informal social groups. The implications of this are:

- It is not necessary for each individual in an institution to possess all the competencies necessary for successful development; rather, it is sufficient when there is a social network of competencies that allows optimal use of available institutional resources for achieving the goals of the institution.
- Although earlier collective or institutional models focused on describing necessary and required qualifications, there is now a preference for focusing on the development of institution-specific competence (Foss & Knudsen, 1996). This refers less to the acquisition of specific qualifications, and more to the development of vocational and institution-specific competencies within a collective group (of course, this may include the individual or group acquisition of specific qualifications).
- To overcome an individualized “competence barrier” described in many sociological competence models (Heyse & Erpenbeck, 1997), there is increasing attention given to the complementary development of leadership competence, flexible competence management, team skills, and individual action competencies defined in terms of group dynamics. Underlying these efforts are very general administrative and institutional models as well as many pragmatic suggestions for action. As yet, there are no middle level theories that can fill the gaps between individual and collective competence models in institution-specific contexts.

#### *(h) Key-competencies*

The search for key competences is motivated by two things: (a) the well founded assumption that competencies acquired in school and vocational settings are learned and used in context-specific ways (e.g., within a discipline, within a vocation, within a company), and (b) that most activities over the life course take place in a variety of social and vocational contexts. This has led to the search for context-independent, key competencies that are equivalent in their use and effectiveness across different institutions, different tasks, and under varying demand conditions. Typical examples of postulated 'key competencies' include basal competencies (e.g., mental arithmetic, literacy, general education); methodological competencies (e.g., planning for problem solving; competent use of a variety of media; computer skills, and so on), communicative competencies (foreign language skills; rhetoric; written and oral exposition skills; and so on); and judgment competencies (e.g. critical thinking skills; multidimensional judgments about one's own and others' performance).

Although the facilitation of key competencies that can be applied flexibly across variable contexts is important and necessary, it has been very difficult to implement this theoretical approach pedagogically. Three problems are especially troublesome:

- The more general a rule or strategy (i.e., the range of different types of situations to which it applies), the smaller is the contribution of this rule or strategy to the solution of demanding problems. Over the last decades, the cognitive sciences have convincingly demonstrated that content specific skills and knowledge play a crucial role in solving difficult tasks. Generally, key competencies cannot adequately compensate for a lack of content specific knowledge (Weinert, 1998).
- In the lively discussions of the meaning of systematic versus situated cognitions, it has been demonstrated that general competencies have virtually no practical utility alone. Rather, specific knowledge, embedded in experience, is required to successfully implement available competences for solving specific practical problems.
- For many key competencies the question is whether and how they can be acquired through planned instructional programs. A typical example is critical thinking. Although there are special training programs for this key competence (Halpern, 1998), their construction and efficiency is controversial scientifically.

The definition, analysis and instructional facilitation of key competencies present a scientific dilemma at the present time. From a practical side, it is important that they be fostered; but from a theoretical/empirical side it appears that their learnability as a separate set of competencies is questionable, and is limited to specific content domains.

#### *(i) Metacompetencies*

Spinoza (1632-1677) used a sophisticated formulation to remark that to know something also means to know what one knows. This captures the everyday experiences that people are more or less aware of what they know and do not know; and what their own intellectual strengths and weaknesses are, and that people know what to do to use available skills and knowledge to solve a variety of tasks, to acquire missing competencies, or to judge from start that there are no chances of success in solving a task. And more: we can not only estimate our own performance possibilities and prerequisites, but can also use these subjective judgments to guide our actions. This knowledge about knowledge is called “metaknowledge”, and the ability to judge the availability, use, compensation and learnability of personal competencies is called “metacompetence” (Nelson & Narens, 1990).

Better learning and performance does not arise just from knowing and doing more. Given similar conditions, those who know more about themselves and who are able to put this knowledge to practical use are likely to perform better than others when solving difficult tasks and problems. Based on this insight, metacognition research, especially studies of the development of metacognitive competencies in childhood and adolescence, has received a great deal of scientific interest over the last decades. A short summary of the research results shows the following:

- One basic prerequisite for the acquisition of metacompetencies is an ability to introspect about one's own cognitive processes and products, available from the third year of life and increasing with age. Introspection is the developmental psychological condition that allows consciousness of ongoing processes of learning,

memory and thinking, subjective experience about available knowledge and abilities, and that underlies the generation of increasing “metaknowledge” about necessary, available, missing, to be acquired, or currently not possible personal competencies. The natural growth of experience-dependent metacompetencies does, however, require school-based support. The observation of one's own and others learning during instruction, learning-related demands and feedback from the teacher, and the transmission of effective problem solving strategies during instruction considerably enriches children's metacognitive knowledge.

- Metacognitive knowledge, combined with subjective consciousness of actions allows diverse forms of unconscious but goal-directed behavioral control. Thus, in addition to declarative metaknowledge, there is development of procedural metacompetencies. These include automatized but potentially conscious skills in planning, initiating, monitoring and evaluating one's own cognitive processes and task-specific actions.
- Metacognitive competence includes both declarative and procedural metacognition. Declarative metacompetencies include experience and knowledge about different task difficulties; knowledge about one's own abilities, talents, knowledge, skills and cognitive deficits; knowledge about learning, problem solving, and explanation regularities; knowledge about effective strategies for learning, remembering, problem solving, trouble shooting; and knowledge about techniques for mastering diverse tasks with available cognitive competencies, for compensating missing knowledge, and for setting realistic goals (see also components of 'successful intelligence' as described by Sternberg, 1996). Procedural metacompetencies are necessary for using metacognitive knowledge and insight to optimize task directed behavior. They include all those strategies for organizing tasks and problems to make them easier to solve (e.g., organizing a task into a meaningful structure; breaking a text into smaller units that are easier to encode; marking and underlining important points to make them easier to remember; constructing memory cues and using them later). They also include the use of effective cognitive aids and tools (e.g., graphics, pictures, titles, analogies); the application of cognitive resources in task relevant ways and at an appropriate level of difficulty; and the continual registration and evaluation of performance progress. To summarize, metacognitive competence is expertise about oneself as a knower, learner and actor.
- Even a brief characterization of metacompetencies illustrates that the construct and related phenomena are very broad and diverse. To be able to use knowledge about one's own knowledge requires mastering many facts, incorporating a variety of diverse experiences, and acquiring different strategies, operations and problem solving heuristics (see Nuthall, 1999). It also requires a realistic self-confidence.
- The variety and number of metacognitive competencies and their variable relations to cognitive, motivational and volitional variables are important causes for the failure of many metacognitive training programs. The term 'learning to learn' is one of the hottest catchwords in current educational theory and educational policy. The core of learning to learn is the acquisition of personal learning competence, that is, the ability to carry out self-guided learning. One set of prerequisites for this ability is declarative and procedural metacognition. However, the same rule holds for metacognitive processes as for key competencies: the more general a metastrategy, the lower its effectiveness in guiding concrete learning and thinking processes. Thus, it is necessary to acquire many specific metacognitive competencies for use in different domains. However, the available teaching and learning models

underlying school practices have tended to fall short in realizing the goals of meta-cognitive competence acquisition. This is because teaching and learning focus on the products of learning (knowledge) and not on reflection about learning processes and their optimization (metacognition).

*(j) Interim Summary*

A summary of the everyday and scientific uses of the term “competence” shows that there are neither common theoretical roots nor common uses in the social and behavioral sciences. To capture the differences between the various theoretical approaches and perspectives, it is necessary to differentiate at least seven different ways in which the concept is used:

- Competence may be understood as intellectual abilities, that is, an individual's general cognitive resources for mastering challenging tasks across different contents, acquiring necessary knowledge, and achieving high performance. In this approach, both general cognitive competencies (e.g., operationalized by IQ) and domain-specific competencies (e.g., verbal, numerical, communicative, social, emotional) can be addressed. The term competence sometimes has a neutral connotation (i.e., it is used to refer to the entire range of an ability from poor to medium to good) and sometimes refers only to those cognitive resources that allow good to excellent performance. Competence in this approach is a **general psychological, dispositional construct**, not a specialized performance construct.
- A second approach to the conceptual meaning of competence begins with the different classes of specific demands, expectations and performance criteria in the environment and classifies those cognitive abilities, skills, knowledge, strategies and routines necessary for mastering them as cognitive competencies. Competence in this approach is a **specific performance disposition**.
- In a third conceptual approach, competence is defined in terms of motivation, not cognition. This approach is concerned with competencies as the **subjective estimation of personal performance resources and related motivational action tendencies**, rather than as the availability of sufficient cognitive dispositions for actual performance.
- The concept of **action competence** systematically combines constructs of the cognitive and motivational approach related to the goals, demands and tasks of a particular action context (e.g., a profession).
- **Key competencies** are those competencies that can be used for attaining good performance across a wide variety of different situations. These include language (native and foreign) skills, mathematical skills and abilities, media skills, and those skills included in a general basic education.
- **Metacompetencies** make the acquisition of new competencies and the use of available competencies more adaptive and efficient. They refer to knowledge, motivational attributions, and volitional skills that allow cognitive resources to be used most efficiently across different tasks, in different content areas, and for different purposes.
- In most social sciences (e.g., sociology, political science and economics), individual competencies are considered only a small part of the total human resources necessary for the development of a society, an economy or an institution.

### 3. Difficulties in conceptualizing the competence concept and some preliminary solutions

Given the number and variety ways in which competence has been defined, it is necessary to thoughtfully decide which aspects, constituents, and components are appropriate to use to address pragmatic goals, and which can (or must!) be ignored. To facilitate this, this section will briefly describe ten problems that arise from different definitions of competence. This list of theory-based problems will allow us to delineate those approaches that provide theoretically acceptable options for a pragmatically oriented conceptualization of competence.

#### *First Problem:*

Unless one argues that the individual prerequisites for the array of cognitive performances and goal directed actions must include all primary mental abilities, all learned skills, knowledge and strategies, the entire complex of learning and achievement motives, and all important vocational skills, the various definitions of competence listed in the first sections of this report are mutually exclusive on a phenomenological, conceptual or theoretical level. Of course, such a broad definition would have little practical value because it would lead to a hyper-definition with no specificity or precision.

Thus, it seems expedient to restrict consideration to specific rather than general intellectual competencies. Such a decision would preclude using descriptions such as “a competent person” to characterize someone who shows high performance in all or many areas. For example, the expression “the competent infant” (Stones, Smith & Murphy, 1973; Dornes, 1994) would not fit this suggested concept of competence. Stones et al. explicitly, and in strong contradiction to earlier psychological perspectives, described the infant thus: “So much does the evidence of recent research belie the earlier contentions, so much does it underscore the competence of the young infant, that we have chosen the title of this book to crystallize the single overriding trend of the findings. We are not using ‘competence’ in the special sense... to characterize the especially successful and well functioning infant, but ... to stress that, from his earliest days, every infant is an active, perceiving, learning, and information-organizing individual” (Stones et al., 1973, p.4).

#### *Second Problem:*

The conceptual tradition begun by Chomsky has had a strong theoretical impact. Competence is understood in a strict domain-specific (linguistic) sense as a universal, species-specific and inherited ability to acquire and creatively use language, with little room for individual differences. This theoretical approach takes its scientific weight from the fact that it offers an explanation for why all children acquire their mother tongue in the first years of life, often despite a non-optimal speech environment. However there is controversy in linguistics and developmental psychology about what count as valid and testable regularities for speech acquisition, which relations exist between competence and performance and how to interpret observable individual differences in mastery of the mother tongue. Chomsky's conceptual framework is difficult to translate onto the acquisition of other psychological phenom-



ena (knowledge acquisition, memory development, etc.), because the separation of competence and performance is relatively arbitrary. In addition, from an educational psychological perspective, it is inter-individual differences in intra-individual change that are the focus of scientific and pragmatic interest -- a theme that is fundamentally ignored in the Chomskian tradition. Because of this and other reasons, the competence concept as proposed by Chomsky is not appropriate for the purposes of the present report.

### *Third Problem*

As already noted, many scientists use the cognitive concept of competence to refer to primary intellectual abilities, rather than to learned skills, knowledge and strategies. This view considers competence as a system of basic mental abilities. If one considers the most important models of intelligence (genetic roots, a distribution of abilities according to a normal-curve, stable interindividual differences over long periods of time, general independence of intellectual abilities and domain specific knowledge), it seems theoretically and pragmatically expedient to restrict the concept of competence to domain-specific learning and domain specific skills, knowledge and strategies.

Such an approach, focused on learned, domain-specific competencies that can be changed by experience, was suggested by McClelland (1973) in his article "Testing for competence rather than for intelligence". He criticized traditional uses of intelligence on conceptual and methodological grounds, because of limited predictive validity (e.g., long term prediction of professional success), and because general intelligence tests put groups outside of the social mainstream at a disadvantage. The scientific alternative he suggested was the measurement of specific competencies. He urged that tests to be developed be valid in the sense "that scores on them change as the person grows in experience, wisdom, and ability to perform effectively on various tasks that life presents to him... Some of these competencies may be rather traditional cognitive ones involving reading, writing and calculation skills. Others should involve what traditionally have been called personality variables, although it might better be considered competencies" (McClelland, 1973, p. 8ff). Examples of such variables included communication techniques, composure (response delay), moderate goal setting, and the development of a sense of self.

McClelland's theoretical approach to competence was initially discussed and enthusiastically endorsed in the scientific literature (Spencer & Spencer, 1993), although it has since been substantially criticized. Three main problems are accentuated: (a) "A fundamental problem with McClelland's research was his failure to define the concept of competence" (Barrett & Depinet, 1991, p. 1019); (b) McClelland's suggested methodology of the "behavioral event interview" did not improve prediction of professional success over traditional intelligence tests. These criticisms, however, did not question the basic utility of defining competence as specific performance dispositions, because the use of the competence concept is often more to diagnose and explain rather than predict individual learning success and interindividual performance differences.

#### *Fourth Problem:*

Most definitions of competence are centered on the individual, and fail to consider the social, physical and task-specific contexts in which performance occurs. Fischer, Bullock, Rotenberg & Raya (1993) questioned such a definition of competence as a general performance disposition, independent of context: “..... skill level is a characteristic not only of a person but also of a context. People do not have competences independent of context... Traditional conceptions of competence and performance fail because they treat competence as a fixed characteristic of the child, analogous to a bottle with a fixed capacity. Performance factors are seen as somehow interfering with this capacity.... Our research shows that children do indeed have stable levels of competence when domain and degree of support are held constant across assessment contexts” (Fischer et al., 1993, p.113f, see also SamurHay & Pastré, 1995).

Because systematic variation of assessment contexts is not possible or is extremely limited, (e.g., one can vary task difficulty by embedding the same problem in familiar and less familiar contexts), finding an appropriate measurement procedure is not only a technical problem, but is a precondition for the measurement of interindividually and inter-institutionally comparable competencies through valid performance indicators.

#### *Fifth Problem:*

Frequently domain specific and domain general competencies are not distinguished in scientific treatments of competence concepts. Because the cognitive sciences have not yet been successful in developing theoretically acceptable definitions, comprehensive taxonomies or appropriate criteria to differentiate domains, it may not be useful to burden the definition of competence with a classification of knowledge, learning and performance domains. For the purposes of the present report, it is sufficient simply to distinguish competencies for curricular and extracurricular learning tasks.

Achievement related competencies defined as curricular include the knowledge, skills and problem solving strategies that are set as learning goals by a school system, school type or school class. This includes the declarative and procedural contents of a subject discipline that must be systematically acquired through instruction (e.g., particular performance levels in reading skills, reading comprehension, writing, arithmetic, mathematical problem solving, various aspects of physics, chemistry, or biology, foreign languages, history, geography, and so on). Because the competencies that must be learned associated with specific performance criteria, testing for these indicators in representative student samples can provide information for reliable comparisons. This can be accomplished by task series that increase in difficulty. By using an appropriate test plan, one can measure the distribution of available competencies within a student population, locate individual differences, identify competence deficits, and measure intraindividual changes longitudinally (see Ercikan, 1998).

Transcurricular competencies, in comparison to curricular ones, cannot be categorized according to subject matter content. They can be differentiated as follows:

- Domain-general competencies (e.g., methodological skills such as observation, experimentation, graphical representation, interpretation of data and text);

- Metacognitive competencies (e.g., subjective estimates of task difficulty, action planning strategies, behavioral monitoring, evaluation of outcomes, techniques for self-organized learning);
- Competence-relevant motivational attitudes (e.g., realistic, positive self concept, interest in learning, tolerance for contradictory information);
- Competence-relevant volitional skills (e.g., work habits, techniques for action initiation and behavioral regulation, concentration skills, action orientation).

The distinction between curricular and transcurricular competencies is a pragmatic classification, rather than theory-based. The teaching plans in most countries are based on learning goals defined by subject content, from which one can deduce which curricular prescribed competencies need to be acquired. Of course it is in principle also possible to determine superordinate learning goals, that are not specifically related to classroom content. However, this has proved problematic. First, the difficulties in defining transcurricular learning goals have resulted in lists of requirements and not in concrete learning goals in many countries. Second, there are many psychological connections between subject-focused learning goals and the related cognitive competencies at one hand and content-general competencies and meta-competencies at the other hand. Because of this, it is recommended to maintain the differentiation between competencies defined as curricular and transcurricular, and to advocate for defining transcurricular competencies more precisely in the future, fostering them more directly in instructional settings, and considering them more explicitly in comparison studies.

### *Sixth Problem*

The concept of competence refers not only to content-specific, task-specific and/or demand-specific performance dispositions, but also to specific functional competencies (e.g., memory competencies, problem-solving competencies, learning competencies). Although many learned skills and strategies as well as general intellectual abilities or capacities play a central role in such functional competencies, it is nonetheless better to exclude this class of cognitive functions from a pragmatically oriented definition of competence. There are two important reasons for this. First, mental functions are part of the basic cognitive apparatus and as such are not learned prerequisites for reaching specific performance goals. Second, although there are many training programs for learning, memory or problem solving, transfer of this training to content-specific tasks or novel contexts is questionable, making claims for their effectiveness rather controversial (Loarer, Chartier, Huteau & Lautrey, 1995).

There is no doubt that the decision to exclude general functional competencies (but not specific skills and strategies that may be related to them!) has pragmatic and theoretical advantages and disadvantages. In addition, it is difficult to draw the borderline between cognitive functions and many cognitive competencies. Thus, the suggestion is to exclude such general thinking, learning and problem solving competencies, but not to exclude, for example, critical thinking competencies or competencies related to learning specific tasks. What is important is to distinguish systems of primary cognitive abilities and learned, demand-specific cognitive competencies.

### *Seventh Problem:*

The concepts competencies, key competencies and metacompetencies are not clearly differentiated in everyday language or in scientific use. This is especially problematic in educational contexts because these three constructs are used to describe different levels of content specificity and functional importance.

This problem can be illustrated with an example. Clearly, it would be naive to expect that particular demands for successful task solution mean that an actor has a single, fixed pattern of necessary intellectual abilities and sufficient cognitive competencies. Disregarding individually available problem solving algorithms (routines), a problem solver uses available knowledge to develop, and test hypotheses and then discards them or uses them as the basis for the next step in problem solving. Different abilities, skills, knowledge and strategies can thus facilitate, compensate, dysfunctionally interact, or have no effect in solving a task or in mastering a series of task demands.

If one considers the entire spectrum of cognitive performances that are necessary, for example, for a member of a particular society, a student of a particular class, or for practicing a particular profession, one would need to construct an enormous number of necessary domain specific competencies to cover each particular demand. The large number of learning objectives can be somewhat reduced:

- if an individual possesses knowledge, skills and/or strategies that are appropriate to organize and reorganize available competencies in adaptive and flexible ways (metacompetencies);
- if an individual possesses competencies that can be successfully applied across a maximum number of different tasks (key competencies, core skills).

Thus, in school or work contexts, metacompetencies and key competencies should be given special attention.

### *Eighth Problem:*

An overview of the different definitions showed that the competence concept is used in scientific terminology

- for cognitive prerequisites for specific performances (objective approach);
- for performance relevant motivational tendencies and expectations (subjective approach);
- for cognitive and motivational/volitional prerequisites for successful action and learning (combination of an objective and subjective approach in the concept of action competence)

so that one can refer to cognitive competencies and competence related motivational attitudes, and volitional skills.

There are two primary reasons for tying cognitive and motivational attributes of competence together conceptually:

- First, performance in specific situations depends on more than cognitive prerequisites -- it also depends on motivational influences. If one wants to infer properties of individual competencies from interindividual performance differences, one has to account for motivational factors by varying assessment conditions or by statistically controlling for motivational variables measured separately. Only the second

alternative is possible outside of psychological laboratories, which means that only dispositional attitudes and stable expectations can be taken into account.

- Second, the long-term development of competencies (and expertise) depends to a great extent on the number of available learning opportunities and on the amount of deliberate practice (Ericsson, Trampe & Tesch-Römer, 1993). Motivational incentives presented by the environment, stable individual attitudes, and volitional skills are important factors in this regard. The developmental status and potential for actualizing a specific cognitive competence is thus always also a function of motivational readiness for systematic learning. Extending the competence concept to include a motivational dimension complicates the defining, measuring and operationalizing the competence construct, even as it adds to its theoretical and pedagogical attractiveness of such an approach.
- When assessing competencies, current motivational influences on performance cannot be measured, and the measurement of stable motives (e.g., achievement motives, anxiety) is not particularly productive. It is feasible only to measure competence-specific motivational attitudes, for example, with reliable and valid questionnaires. The most promising dimensions in this regard are aspects of the self-concept and self-efficacy beliefs about the origins and use of specific competencies.

#### *Ninth Problem:*

It would not be useful to limit attention to cognitive and metacognitive competencies if one is concerned with success in broad fields of action across a variety of tasks (e.g., in school, in a particular school subject or in a profession), rather than with solving single problems or mastering particular tasks. Thus, the concept of action competence includes an extensive configuration of cognitive and social competencies, motivational tendencies, and volitional skills. Comparative measurements of individual action competencies are, however, more complex. They require that suitable scales to measure relevant cognitive competencies and related motivational attitudes be available or constructed *ad hoc*. Any concept of action competence constructed from different components must then be validated with appropriate success criteria. This creates an arduous procedure that so far has been used primarily for predicting vocational success or personnel selection.

#### *Tenth Problem:*

As noted above, competence is understood to include learned cognitive performance dispositions and complementary metacognitive strategies for successful mastery of task demands. Individual competencies and interindividual competence differences are always a confounded result of inherited talents, developmental regularities, general environmental influences, and the quantity and quality of specific learning opportunities. Even an approximate separation of the different causal influences is impossible without costly longitudinal studies.

However, an analysis of available longitudinal studies as well as available twin and adoption studies shows that arguments for a strong genetic contribution (“nature”) are just as untenable empirically as arguments for a strong environmental determination (“nurture”), regardless of how much these positions are popularized in the press:

- Hypothesis of a broad genetic determination of cognitive development (e.g., Jencks et al., 1972; Herrnstein & Murray, 1994) are strongly contradicted by available empirical findings -- even though genetic differences strongly influence the development of cognitive competencies. The general effects of environmental differences are especially relevant to schooling: "There are important school effects... and ... it is clear that school effects can be very substantial indeed" (Rutter, 1983, p.13).
- Hypotheses of radical environmentalism are also empirically untenable. This is especially true for the utopian expectation that all students can achieve the same level of learning if instructional quality is improved overall and if individual students are provided an optimal time to learn (Bloom, 1976).

Part of the lack of theoretical clarity and resulting controversy is due to that fact that two developmental phenomena with different regularities are frequently confused in the literature (Weinert & Schneider, 1999). One of these phenomena concerns intra-individual development of cognitive competencies, for which the intensity of cumulative learning, the quantity of learning opportunities and instructional quality are important variables. The other phenomenon concerns the origins and development of interindividual differences in the development of cognitive competencies. From about the 5th year of life on, there are large stabilities in these interindividual differences that are caused by a mixture of (sometimes covarying) genetic differences, differences in early childhood facilitation, and the application of the Matthäus Principle to cumulative learning ("who already has, gets more") (Weinert & Helmke, 1997).

In interpreting empirical results, it is important to note that general abilities and qualities of knowledge are increasingly intertwined over the course of development (Sternberg, 1998; Weinert & Helmke, 1998), as shown in statistical analyses (knowledge can be more or less intelligent, that is, represented in multiple forms, and variably interrelated and flexibly available).

All in all, the development of domain specific competencies appears to be a process of cumulative learning, in which interindividual differences in developmental and performance level remain relatively stable, even under favorable instructional conditions.

The analysis and measurement of individual competencies and inter-individual and inter-institutional differences in competencies can only be approached through statistical analyses of systematic influences on the development of performance indicators and underlying competencies that use sufficiently large and representative samples of individuals and tasks. Such comparisons are possible, for example, between national or regional school systems (and discernible single factors in such systems), and between different types of schooling or instructional conditions. Because the influences on the development of competencies often covary in unknown ways, findings from studies with a carefully planned research design can also provide testable scientific hypotheses for explaining the basis of average performance and competence differences. However, for methodological and theoretical reasons, there are always many degrees of freedom in the interpretation of these data and many difficulties in strict hypothesis testing in such large field studies.

This short list of ten theoretical problems and seemingly acceptable solutions that can be found in the literature on the concept of competence omits questions of collective or group-specific competence. This is because theories and phenomena at the institutional (or group) and individual level address fundamentally different phenomena.

#### **4. An analysis of some constituents and components of the concept of competence**

An analysis of the different definitions and theoretical status of concepts of competence might lead to the inference that the quality of a theory is only weakly correlated with its practical use for educational purposes. This is one important reason that pragmatically useful models of competence are unlikely to be derived directly from available psychological theories. A more promising strategy is to analyze different concepts of competence with the goal of identifying essential theoretical constituents and components. This exercise can provide criteria for a pragmatically useful definition of competence.

##### *4.1. How many theoretical constructs are required to describe and explain nontrivial interindividual differences in performance?*

There is little consensus in the social and behavioral sciences about the answer to this question. Nor have the neurosciences, despite considerable progress, been able to approach defining the neurobiological or neuropsychological conditions for cognitive performance or performance differences.

(a) Looking just at mainstream psychological research, the approach for a long time was to take the concept of intelligence as the most important theoretical basis for predicting and explaining cognitive performance differences. Although results from the thousands of studies were generally in line with expectations, they were also disappointing. Mean correlation coefficients of +.5 (varying between +.1 and +.8) between intelligence test scores and many cognitive performances in school and in work settings have been the rule.

The classical concept of intelligence (“good thinking, correct judgments, smart actions, successful learning”) has over time been supplemented with newly “invented” (and not “discovered”) facets of intelligence. These include Gardner's (1983) „multiple intelligences” (logical-mathematical intelligence, verbal intelligence, spatial intelligence, musical intelligence, kinesthetic intelligence, interpersonal intelligence, and intrapersonal intelligence); „practical intelligence” (Sternberg & Wagner, 1986); „social intelligence” (Thorndike, 1920; Keating, 1978) and, somewhat evocative and popular, “emotional intelligence” (Salovey & Mayer, 1990; Goleman, 1995). Additional facets are “operative Intelligence” (Dörner, 1986), “successful intelligence” (Sternberg, 1997), and “intelligence as potential for learning” (Guthke, 1997). Although all these concepts broaden the complex of abilities that one can label as intelligent, there is no consensus among lay people or scientists about the use of these concepts (Sternberg & Berg, 1986). Thus many suggest limiting the concept of intelligence to its classical meaning and psychometric measurement.

There have been many suggestions for how to classify primary intellectual abilities in the last 100 years. R.B. Cattell (1963) developed an especially important and influential system. He differentiated general intelligence into fluid intelligence (intellectual potential that is relatively independent of education) and crystallized intelligence (intelligence acquired through education). J. B. Carroll (1993) used this hierarchical model among others to perform a monumental new secondary analysis of available intelligence research. From this he developed his “Three Stratum-Theory” of intelligence. The model contains sufficient evidence for general intelligence (the “G-factor”). On a second level he found eight second-order-factors (fluid intelligence, crystallized intelligence, memory and learning, visual perception, acoustic perception, originality and fluency of ideas, speed of information processing, and mental speed). On a third level of the model, the eight second-order-factors can be described as 68 sub-constructs with between 4 and 15 abilities each. This is the most comprehensive hierarchical model to date (Carroll, 1993) In principle, it contains all psychometrically defined abilities that have been addressed in intelligence research.

(b) Intellectual abilities are important prerequisites for the acquisition of knowledge and skills. “Working memory” plays a key role in these acquisition processes (Wittmann, Süß, Oberauer & Wilhelm, 1998).

Knowledge can be differentiated into general world knowledge (generally measured by vocabulary tests that are part of many intelligence measurements, and overlapping considerably with what is defined as crystallized intelligence), and more arbitrary specialized knowledge. This specialized knowledge is necessary for meeting content-specific demands and solving content-specific tasks. In contrast to general intellectual abilities, one can consider arbitrary knowledge as a demand-specific competence.

Whether one considers mathematics, language, history, biology, physics, geography, chess, soccer, art, music or any other area of “normative” knowledge, this type of knowledge always includes both declarative knowledge (knowing what), and procedural knowledge (knowing how). There is good evidence that it is appropriate to describe the knowledge necessary for solving a class of tasks in terms of a hierarchical model. This can be more easily illustrated in domains such as mathematics than in those such as history or foreign languages.

An approach that is especially important in educational psychology is Gagne's (1962) model of hierarchical knowledge. This model is built on asking about the knowledge set necessary for understanding, learning and performing well on a criterion task. The same question can be asked for each subordinate set of psychological knowledge, which provides a description of knowledge that is increasingly more and more elementary and general. Thus, the base of each knowledge and learning hierarchy rests on primary mental abilities. An additional assumption in Gagne's model is a general learning and transfer capacity, along with the “logic of knowledge acquisition”.

As noted above, strict hierarchies are expected in individual knowledge development only in mathematics and natural science domains. In other areas, the organization of knowledge is not as logically organized, and the acquisition sequence for new knowledge is less clearly hierarchical. However, in all domains there is at least a “loose logic” for the acquisition and understanding of new knowledge that includes necessary or facilitatory cognitive prerequisites, and specific knowledge and skills.



A large portion of interindividual performance variance in cognitive tasks can be accounted for by a combination of intellectual abilities and task relevant knowledge for which there are countless possible combinations, cumulations and compensations. Such a combination of general abilities and specific knowledge competencies has proven especially productive in differential and educational psychology for predicting future performance and/or explaining observed performance differences. Interindividual performance differences are very stable even in elementary school (correlation coefficients between .6 and .8 between the 3rd and 4th grades). Prior knowledge accounted for over 30% of the variance in performance, and general intellectual ability differences only 10% (as expected this was higher, for example, for mathematical problem solving than for arithmetic tasks) (Weinert & Helmke, 1998). Theoretical considerations and practical reasons thus suggest that the concept of competence should be limited to specific knowledge and skills and should exclude intellectual abilities for analyses of school achievement.

#### *4.2. Competencies and metacompetencies*

Intellectual abilities and content-related knowledge alone do not determine performance quality and quantity. An individual must also possess the skills to apply available competencies in a concrete task. As noted above, knowledge about one's own skills and abilities is called metacognition or metacompetence. Metacognitive knowledge and conscious awareness of actions allow the application of increasingly intelligent strategies for using available competencies in solving new tasks, and allow increasingly conscious monitoring during problem solving. Metacognitively guided actions lead themselves to improvement in metacognitive competencies.

This complementary pattern in the development of competencies and metacompetencies has fascinated many cognitive scientists, but has led to an inflation in the use of metacognitive constructs and to conceptual fuzziness that has been criticized, for example, by Siegler and Kotovsky (1986): "Ability to learn, to generalize, to go beyond the information given, and to use strategies flexibly and appropriately are all attributes of the venerable construct. How exactly does metacognition differ? ... Empirical relations between measures of metacognitive knowledge and performance have frequently not been found when expected... Even when such relations do appear, it often is unclear exactly how metacognition influences performance. Beyond this no one knows how well the various mental operations that are said to constitute metacognition correlate with each other. In other words, we have no measure of construct validity, despite the construct having been used quite widely for a full decade" (Siegler & Kotovsky, 1986, p. 428ff).

There is no doubt that this criticism of typical use of the naively understood concept of metacognition is still justified. Four theoretical and methodological issues are especially problematic in metacognition research:

- rampant confounding of cognitive and metacognitive competencies;
- failure to differentiate between declarative and procedural metaknowledge;
- difficulties in differentiating between conscious control of cognitive processes and unconscious action regulation through automatized skills;
- close relations between metacognitive competencies, motivational tendencies and volitional skills (a mixture of will and skill; see Salomon, 1987, p.6).

Nonetheless, a better theoretical clarification of cognitive performance and individual performance differences requires understanding the role of metacompetencies. However, metacognition is a useful theoretical construct only when it is used in a sophisticated way (see Cavanaugh, 1989; Nelson & Narens, 1990; Weinert, 1991). For example, according to Cavanaugh (1989) it is necessary to differentiate systematic metaknowledge (a person's total set of knowledge about the functional laws and regularities of the human mind), epistemic metaknowledge (knowledge about one's own competencies, personal strengths and weaknesses; knowledge of personal learning style; metacompetencies of planning, monitoring, control and evaluation of one's own cognitive activities --with very large interindividual variability); and "on-line" experiential knowledge that can be called into awareness (about currently ongoing processes of learning and problem solving).

The same generalization noted above for cognitive competencies apply to metacompetencies as well: the more general a (Meta-) strategy, a (Meta-) rule or a (Meta-) skill, that is, the more it can be applied across different situations, the less is its specific contribution to solving a particular, difficult content-specific problem.

There is good evidence that metacompetencies are especially efficient when they arise from a system of more or less general and specific (Meta) skills. For this reason, it is important to teach relevant metacompetencies along with cognitive competencies, and to test them as a combined competence system.

#### *4.3 Competence and competence-related motivation*

There is no direct psychological relation between cognitive competence and general motivational systems (e.g., achievement motivation). That is, the addition of measures of dispositional motives does not increase multiple correlations between individual competence and cognitive performance. However, this changes if one supplements measures of general motivational systems (need for achievement, security or social contact) with measures of competence-related motivational attitudes. These include: Self-confidence in specific personal competencies, attribution style for success and failure outcomes within a specific knowledge domain, feelings of self-efficacy for achievement related activities; competence-related test anxiety; goal orientation; personal expectancies about the relation between available competencies and task demands.

In a similar way, although one can identify specific competence-related volitional skills, general factors such as study habits, generalized patterns of attention control and automatic mechanisms of controlling goal-directed behavior also always have an important impact on their activation.

Empirical findings have shown reciprocal effects between motivational attitudes and the development of competencies. Thus, motivation should not be taken as a component of the competence concept, but rather an important condition for specifying the relation between competence and performance.

## 5. Suggestions and recommendations

The many implicit (in word use) and explicit (in theoretical frames of reference) definitions of competence are so heterogeneous that only a small, vague conceptual core remains. It is therefore necessary to decide which aspects and components of the different competence concepts should be used as definitional criteria to for achieving scientific and pragmatic objectives.

The subjective meaning of competence should be excluded from the definition of competence all together -- even in everyday language we differentiate the phrases "one is competent" and "one believes him/herself to be competent". Similar arguments suggest excluding a pure motivation-centered definition of competence. Of course, there are individuals with high competence but weak motivation to translate abilities into performance through personal effort. However, because the relations between competence, motivation and performance are so strong, the theoretical construct of competence-related motivation should not be entirely excluded.

The concept of a universal, inborn, domain-specific competence as a prerequisite for the acquisition of species-specific knowledge systems (especially language) is also not appropriate for the present purposes, because there is no attention to individual differences in this approach and because competence is not defined as an empirically measurable construct.

Thus, competence and competencies should be understood primarily as the mental conditions necessary for cognitive, social and vocational achievement. If one decides for such a conceptual restriction, there are still two options for how to proceed:

### *(a) Conditional approach: which cognitive competencies are there?*

An exhaustive definition of competence would have to include all the intellectual abilities, content-specific knowledge, skills, strategies, metacognitions and action routines that contribute to learning, problem solving and a variety of achievements. Such a definition would mean that the concept of competence covered all of a person's cognitive resources, that is, all those mental conditions that underlie individual performance, intraindividual performance changes, and interindividual performance differences at any given point in time. The advantage of such a broad definition is also its greatest disadvantage. One would be confronted with a problem not yet solved in the 100-year history of scientific psychology: a complementary classification and performance-specific integration of ability and knowledge. There is neither a theoretical nor a practical solution to this problem at this time.

The difficulties in finding a theoretically legitimate and pragmatically useful decision to the question of how to define competencies are evident. This can be illustrated by an example from mathematics instruction in the 3<sup>rd</sup> and 4<sup>th</sup> grades. Although achievement differences in arithmetic tasks can be almost totally explained by differences in prior knowledge, for mathematical problem solving general intellectual abilities are important as well, although the largest influence still comes from prior knowledge. In addition, with increasing improvement in relevant prior knowledge, there is a decrease in the influence of general intelligence (Helmke & Weinert, 1997). In light of this and

similar empirical findings, it is not only justified, but expedient to ignore psychometrically defined general intellectual abilities in favor of specialized knowledge and skills.

*(b) Functional approach: Which cognitive competencies does one need to master tasks and task demands*

The answer to this question does not require considering all cognitive resources, but rather requires a classification of those demands, problems and tasks for which individuals require special cognitive prerequisites. A comprehensive psychological theory of human abilities (that does not exist!) is not necessary for this approach, nor is a comprehensive sociological classification of environmental demands. What is required is a prototypical, typical and specific characterization of classes of performance demands, performance criteria and indicators of competencies (see Bloom, Hastings & Madaus, 1971; and a number of subsequent publications). There is a good deal of scientific and practical information available for this task: curriculum theory, measurement models, task profiles for most vocations, (often defined as a set of action competencies), and task profiles for typical life situations (economic, administrative and political activities, interaction with mass media, leisure behavior, travel, social conventions, etc.) and for specific action fields (bank consultant, games such as chess, sales skills, etc.).

One can identify specific configurations of cognitive competencies that are necessary for good performance for each of these everyday, school and work demands. Primarily, this is a system of learned skills, knowledge, strategies and metacognitions.

In many cases content-specific competencies are appropriate for mastering a large number of demands that can be embedded in a variety of different social and cognitive contexts, not just a single task. Examples are the variable uses for competencies such as reading, writing and arithmetic. Turned round, it is also true that necessary competencies can vary widely as tasks in the same demand area increase in difficulty. To take just one example, any area in the natural sciences demonstrates the relation between demand level and competence level.

On the basis of the research reviewed in this report, the options outlined above, and pragmatic considerations, we make the following recommendations for using the term 'competence / competencies' as the conceptual basis for comparisons of school-based performance:

**I.**

A choice of the second option is recommended. The first option, in which competencies are defined as including both content-free intellectual abilities and learned, content-specific knowledge, confounds two different theoretical approaches: the psychometric model of intellectual abilities and ability differences, and the theory of knowledge acquisition and its use in subsequent learning, problem solving and automatized behavior. The degree to which such a theoretical mix can lead to confusion is shown in the history of research on "overachievement" (someone learns more and achieves more than one would expect from his or her intelligence level) and "underachievement" (someone learns and achieves less than expected from intelligence level).

## II.

The choice of the second option means limiting the concept of cognitive competence to learned knowledge, skills and corresponding metaknowledge. There are at least four advantages to this:

- A large proportion of individual differences in intelligence is captured by learning performance variance (see Weinert, 1996, p.20), so it is not necessary to address the theoretically and methodologically difficult problems of the role of ability differences in knowledge acquisition.
- It is possible to use hierarchically and heterarchically constructed performance tests as valid indicators of competence hierarchies and competence components.
- In contrast to an ability centered concept of competence, one can directly infer the effectiveness of prior learning opportunities through knowledge-centered (or task demand-centered) competencies. This will make national and international comparison studies possible and meaningful.
- The knowledge-centered concept of competence can be applied to the large number of types of performance demands in daily life, school and work activities.

In addition to these four advantages, the knowledge-centered concept of competence has one severe disadvantage that must be addressed. This is that to a large extent, intellectual abilities determine how well and how many new knowledge components someone can acquire. However, the history of research on the gifted has shown that intelligence level provides only a very general measure for predicting knowledge acquisition and the level of cognitive achievement.

## III.

In the past, the traditional knowledge-centered concept of competence led to an inflation of more specific, narrow competencies, a frequent source of criticism in curriculum development. A justified response to this was to ask whether there might be a smaller number of key competencies, key qualifications, or basic skills that made it unnecessary to address the acquisition of specific knowledge and that allowed an individual to master new demands. Although this hypothesis could not be supported by cognitive psychology, many politicians, educators, journalists and others still see the postulation of key competencies as a breakthrough. Incorrectly, we must add (see Weinert, 1998).

Of course, there are skills and competencies that are useful in many learning situations and in the solution of different problems. These include a command of the mother tongue, foreign languages, reading and writing procedures, mathematical skills, and nearly all metacompetencies. These key competencies, however, are no substitute for content-specific knowledge, especially when solving more difficult problems. Even the hope that one could use a few key competencies to quickly acquire content-specific knowledge through electronic media is a purely utopian view. Only those with enough initial knowledge are able to use new knowledge effectively. Thus it is necessary that everyone acquire many important content-specific competencies, including especially narrowly defined key competencies.

In addition to cognitive competencies, competence-related motivation plays a very important role in actual problem solving behavior and in the long-term acquisition of expertise. Thus, all measures of competence should also include measures of competence-specific motivational aspects.

As a general conclusion, we must say that Paul Valery's comments are appropriate for characterizing our considerations of the acquisition, use and measurement of skill- and knowledge-centered competencies: "Everything simple is theoretically wrong; everything complicated is pragmatically useless." To find compromises that satisfy both theoretical and pragmatic requirements is not only a continuous task for the social and behavioral sciences, -- it also requires attention and effort from all those who are concerned with life long learning.

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# A Glossary of Terms related to Competence

## Ability

- (a) The internal power to perform an act, or achieve an outcome either physically or mentally. May be intrinsic or acquired by education and/or practice.
- (b) General cognitive ability is concerned with all types of cognitive and/or intellectual tasks, regardless of content.
- (c) Specialized ability has to do with a specific kind of task (or a defined class of tasks).

## Achievement

- (a) Success in bringing an activity to its desired outcome.
- (b) Degree or level of success attained in general or in some specified area.

## Aptitude

- (a) The capacity (potential ability) to perform an as yet unlearned task, skill, or act.
- (b) Academic or scholastic aptitude is the likelihood of achieving a given degree of success in academic pursuits.

**Capability** is the maximum effectiveness a person can attain under optimal conditions of education (learning and/or training)

**Capacity** is a loose synonym for ability, aptitude and capability; often with implications of innateness.

**Cognition** is a general term for any process (and the underlying structure) that allows an organism to know and to be aware. It includes perceiving, learning, remembering, reasoning, thinking, speaking and judging.

## Competence

- (a) is cognitive fitness for a particular class of tasks;
- (b) a roughly specialized system of abilities, proficiencies, or individual dispositions to learn something successfully, to do something successfully, or to reach a specific goal. This can be applied to an individual, a group of individuals, or an institution (i.e. a firm).

**Competence motive** is the individual's active need to contact and master the environment as an end in itself as apart from the extrinsic benefits of this activity.

**Expert** One possessed of particular (usually learned) proficiency in some branch of science, sport, art, or industry.

## Intelligence

- (a) is a hypothetical construct underlying an individual's abilities to deal with abstractions, learning and performance in novel situations. (ability to judge, comprehend and reason).

- (b) is a composite of a multitude of separate elements of ability broadly categorized within the ability to understand and deal with people (social intelligence), the ability to understand objects (concrete intelligence), and the ability to understand and to deal with verbal and mathematical symbols (abstract intelligence).

**Key competence** is a central competence

- (a) upon which (many) others depend;
- (b) which facilitates understanding and learning a variety of different concepts, rules, principles, strategies, and skills;
- (c) which could be applied to solve different problems in different situational contexts.

**Knowledge** is the body of understood informations possessed by an individual or by a culture.

**Meta-knowledge** (meta-competencies) is knowledge about knowledge and deals with the cultural and individual repertoire of rules and regularities for the proper use of the available knowledge:

- (a) declarative meta-knowledge
- (b) procedural meta-knowledge

**Performance**

- (a) is what a person does when faced with a task
- (b) is a personal activity considered as producing a result
- (c) is achievement evaluated with respect to its adequacy.

**Proficiency** is an ability of a certain degree, usually of a high degree, that is necessary for the performance of a task or the involvement in a vocation.

**Skill** is

- (a) an acquired aptitude;
- (b) an ability to perform complex motor and/or cognitive acts with ease, precision, and adaptability to changing conditions.

**Talent** is a high degree of ability or aptitude in a particular area, largely innate (Giftedness: possessing a high degree of intellectual ability and/or a high degree of special talent).