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Hiroshima University and Graz University Joint Research Project
A Comparative Study on Teacher Education System between Austria and Japan for Constructing a New Conception of Knowledge for Teachers

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The Competence Performance Distinction and It's Implications for Teacher Education and Training

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INTRODUCTION

The Austrian school system (see e.g. Hackl, 2003; Roth, 2005; European Commission, 2006/07**;** Eurydice, 2007) as well as the Austrian Teacher Education and Training (TET) system (see e.g. Buchberger, 1995; Buchberger & Seel, 1999; Gassner & Schratz, 2000; Hackl, 2003; Buchberger et al. 2004; Friehs, 2004) seem to have been in a good order until at least 2003 according to the head officials: "Austria is in the position not to deal with a big problem of Teacher Demand and Supply. So the focus of teacher policy was strengthened on the quality of teaching and learning. …. The professionalism of teachers has assumed top priority. In order to gain and renew the skills needed for their profession, teachers should be immersed in the process of lifelong learning – and should ensure that their pupils are made aware of the importance of their own learning process." (Sektionschef Dr.Heinz Gruber for the Ministry of Education, Culture and Science in his foreword for Hackl, 2003, page 2)

It is also true however that TET has been a hot topic for several years in Austria and Europe, even for the public (see e.g. the Austrian and German newspapers Der Standard, Kleine Zeitung, Der Spiegel, Die Zeit), for at least the following three reasons.

- Top down: the European Commission (EC) is forcing the European Union (EU) member states to improve and to harmonise the educational systems in Europe. This pressure reflects competition in the global economy, mobility within Europe and economical-social welfare.
- Bottom up: Some EU member states have already (e.g. Finland) or want (e.g. some German provinces, see Terhart, 2000) to improve their local school systems or are discussing changes (e.g. Austria, see Haider et. al., 2005) in view of their unfavourable results in OECD-PISA studies, that assess achievements of students in core competencies (reading, mathematics, sciences, problem solving).
- Horizontal: Costs for schools and TET are high (e.g. Hackl, 2003; Jimenez at. al., 2003), and their effectiveness has been questioned since the unfavourable PISA-results (e.g. Van Ackeren & Klemm, 2000; Oelkers & Oser, 2000; IEA, 2008).

A prominent idea (e.g. Perlberg, & Kremer, 1979; Burke, 1989; Carr, 1993; Hustler & Intyre, 1996; Bowden, 1997; Bromme, 1997; Oser et al., 2006) for improving education of the general population is based on improving the competence of individuals by means of the competences of teachers and of the whole school system (in terms of their capacity to solve problems and foster renewals) - however the influence of the competence of teachers on the educational level of the population is not well investigated (e.g. Weinert, 2001) and probably is not very strong in

comparison to other influences (e.g. in Germany the social level of the family is important for interpreting the variance of PISA-performance). Nevertheless, the concept of competence must remain central for education (e.g. Bowden, 1997; European Commission, 2005a, 2007), and according the words competence and 'Kompetenz" are in strong co-citation with terms from the educational sector (see e.g. http://corpora.informatik.uni-leipzig.de/ and http://beat.doebe.li/bibliothek/w01343.html), and even more important, the concept of competence is used to define the core of the teacher's professionalism (Bromme, 1997; Weinert, 2001, Korthagen, 2004, Hustler & Intyre, 1996, Calderhead, 1989). Furthermore, although education depends on multiple components, at least one of them is the teacher's competence. Without teachers professional competence education would be regressive. Thus, the idea of *competence oriented TET*, which I am focusing on, has some appeal (Arning, 2000; Czerwenka & Nölle, o.J., 2003; Tramm, 2005; Oser et al., 2006). In more general terms competence orientation is required at all levels of the educational system e.g. by Friedrich Buchberger.

In general, education is in a transition from input control ("which content should be and is taught?") to output control („which competencies should result from the learning and teaching processes?"). As a consequence current TET must base not only focus on knowledge (Wissen) but also on action (Handlung) as educational goals. Thus the aim of current TET including content of curricula and teaching goals and standards, is to teach competence of action (Handlungskompetenz, action-competence). Action-competence may be defined as the ability to generate successful actions in an unlimited number of different situations based on a limited number of knowledge units and skills (e.g. Volpert, 1992, 1994).

The current emphasis is to modularise teacher education in terms of the methods for teaching the knowledge component as well as the action component and integrating these into action-competence in a given context or situation,. A module may be defined as a teaching and learning unit which integrates 'theoretical' (conceptual) knowledge and practical performance. Often the terms 'competence' and 'module' are used synonymously, one module is assigned to one competence and vice versa. According to my understanding this is an inappropriate approach. That I will clarify below.

I will now discuss which specific *contents* and *methods* are currently in use or under discussion, and to what extent the intended action-competence oriented modularised TET is planned or already in use?

CONTENTS OF COMPETENCE ORIENTED TET

As previously mentioned the current focus is on teaching and acquiring action-competencies. The question therefore arises as to which competencies are seen to be important for being taught in TET.

So-called standards in TET are under discussion or already used in Austria (e.g. Haider et al.. 2005) and Europe (e.g. Oser, 1997a,b, 2001; Oser & Oelkers, 2001; Viebahn, 2003; Bircher, 2005, Tramm, 2005) in order to characterise basic competencies of professional teachers; standards are planned to be used or are already used for defining the content of curricula, the learning and teaching goals (Lehr-/Lernziele), "best practice lists" and assessment/evaluation criteria. Sometimes a distinction between standards and competencies is made, most often however, these terms are used imprecisely. For instance if the definitions of a competence and of a standard refer to observable behaviour like "the ability to do/perform ….". The descriptions of standards as well as competencies vary not only in vagueness but also in level (general vs. specific) and number, amount of theoretical grounding, type (e.g. content vs. process standards).

Furthermore, the methods for generating standards and the amount of acceptance of proposed standards by the professors and students involved in TET vary a lot.

METHODS OF COMPETENCE ORIENTED TET

As previously mentioned the currently propagated method is modularization intensed to integrate knowledge and action skills, "theory and practice" ("Theorie und Praxis") into action-competence.

METHODS FOR ASSESSING TEACHING-COMPETENCIES

Output control orientation was lead to current discussion in Europe as to whether, why and how to assess the teaching competencies acquired by TET that aim at standards (e.g. Hartig et al., in press). Furthermore, the assessment of individual competencies is essential for personalized and individualized training of competencies and for evaluating the professors/students competencies and the success of TET interventions.

One special method, which seems to be widely accepted is the individual portfolio – sometimes a European educational passport (Europass http://europass.cedefop.europa.eu/europass/home/hornav/Introduction/navigate.action) and an ePortfolio (e.g. Brahm & Seufert, 2007). In any case, action-competence has to be documented and carefully detailed according to Oelkers & Oser (2000, S. 57): „Es wurde nicht in erster Linie nach dem Wissen in den entsprechenden Bereichen gefragt, sondern nach den erworbenen Handlungskompetenzen, wobei diese dann als erworben gelten, wenn eine Art Portfolio vorliegt, d.h. wenn auf allen Ebenen analytisch, theoretisch, nachahmend und praktisch selbständig gehandelt worden ist und die Kompetenz im Feld aktualisiert werden kann."

METHODS FOR TRAINING TEACHING-COMPETENCIES

Central demands of European TET are the adaptability and mobility of teachers in a so-called dynamically changing knowledge society (e.g. Buchberger et al. 2000; European Commission, 2005b)

These demands require at least two challenges. (a) The education and training of competencies, as contrasted with merely training of behaviour in specific situations. Competencies have the advantage of allowing the individual to behave adequately in new situations – not only in those situations which have been used for training. Furthermore, (b) continued education and life long learning (e.g. Lenz, 2004) are required not only of teachers to fulfill the European demands of adaptability and mobility.

As previously mentioned, action-competence oriented TET is especially required. The questions to be addressed are which specific TET methods are currently in use, and to what extent is the intended action-competence oriented, modularised TET planned or realised?

'Theoretical' and practical TET are only loosely integrated in most European countries (including Austria), except for Finland and a few others. The Austrian TET system for elementary teachers is currently in a phase of transition. In addition to modularisation, several methods for so-called innovative TET are currently under discussion or in use (e.g. Buchberger et al., 2000; Kumpulainen, 2000; Klinger, 2004; Lang, Hansen, & Bünder, 2002; Lang & Bünder, 2004; Lang & Olson, 2004; Van Petegem, de Loght, & Shortridge, 2004; Lang, Drake, & Olson, 2005; Tramm, 2005). Among the current discussed and recommended innovative methods for TET are the following, cited by key words: powerful learning environments and cultures of learning, active learning, problem-centred learning, explicit research component and working on an academic masters thesis, networking, curriculum workshop, collaborative teacher education,

action oriented learning in concrete (group-) projects, virtual learning environments, cycle of self-responsible planning, action and reflection/evaluation in dealing with professional tasks and problems, comprehensive integration of eLearning and eTeaching.

I will briefly list in telegraphic style some critical remarks reflecting my views of current developments of TET.

- How to define action-competencies and standards important for teaching? No clear distinctions between competencies, standards, performances and demands/challenges of situations have been made until now. Definitions are (a) often vaguely worded without any reference to observable behaviour or performance in specific teaching situations (see e.g Arning, 2000; Hackl, 2003, p.30) or (b) presented in terms of performance (standards) with the assumption of a one to one correspondence to competencies. Both types of definitions lack scientific meaning.
- Even for the same granularity level (detailed or broader categorization) in defining competencies which are relevant for teaching, no agreement among experts has been reached. This is easily validated by comparing various competence lists (see e.g. Viebahn, 2003).
- Which level of granularity is appropriate? Either (a) long lists with definitions (e.g. Oelkers & Oser, 2000; Oser, 1997a,b, 2001), structured merely at surface level, are generated, or (b) only a few less specific multidisciplinary competencies and standards are agreed to (e.g. in case of Pädagogische Hochschule (PH) Zürich only ten competencies are described, see Bircher, 2005, 2006; Sonderegger, 2005) and those are only loosely connected with concrete teachers behaviour in specific teaching situations.
- As a consequence, the acceptance by the TEoT-professors of proposed competence lists and descriptions is low (e.g. Bircher, 2005; Sonderegger, 2005), even when an elaborated method (Delphi-method) has been used for generating the competencies (Oser, 1997a,b). As a consequence, the teacher training institutions develop their own idiosyncratic competence lists (Bircher, 2005, 2006; Sonderegger, 2005, with the result that the competencies of teachers from various TET institutions are not comparable..
- The required standards and competencies often are merely defined pedagogically (Sonderegger, 2005), and it is not clear how to add and to combine them with the didactical competencies and principles specific for a given discipline.
- The assessment of competences of individuals and of institutions are sometimes neither conceptually nor practically clearly separated from each other.
- How to assess unobservable competencies? Which observable behaviour in which situation is taken as indicator of a competence or of a bundle of competencies? For example, can the method of portfolio be taken as an objective method for reaching comparable diagnosis?
- Does it make sense to try to train only one specific competence in a specific module? Is this the kind of challenge which the classroom offers for teachers?
- Various goals, e.g. using a method for competency training and for implementing new educational process, are sometimes undistinguishable, e.g. in case of curriculum workshops. This may result in conflicting goals and difficulties of evaluation.
- Competence assessment und competence training most often is not personalized, as a result individual differences in experiences and pre-knowledge, personality and attitudes etc. are not taken into account.
- Professional TET should not be an art (e.g. Morgan-Fleming, 2000). It must be possible to learn contents and methods needed to become a professional educator of future teachers and to be able to realize (action-)competence oriented TET.

In the following I present a theory which can be applied to solve almost all of the above mentioned challenges.

THE COMPETENCE-BASED KNOWLEDGE SPACE THEORY

THE COMPETENCE-PERFORMANCE DISTINCTION

A contribution of psychology for improving (action-)competence oriented TET is to provide a theoretical framework for guiding and implementing new methods for assessing and acquiring competencies of future teachers.

A distinction between non observable competence, skill, ability, etc. on the one hand and observable performance, behaviour, action, etc. on the other hand is traditional made in psychology to 'explain' observable behaviour on the basis of underlying, hidden competencies etc. of a person. Competencies are viewed as relatively stable entities that are properties of a person, and – in the case of TET - can be acquired by education and training. Existing competencies of a person might – under appropriate circumstances - be activated in and by a given situation and its demands and challenges. The activated competencies determine and guide the behaviour of that person in that situation (e.g. in a special classroom constellation), together with other aspects of the situation (e.g. legal constraints and rules, given curriculum, type of school or teaching method) and of the person (e.g. personal constraints, aims and goals, expectations, emotions, motivation). If the activated competencies are adequate for the given situation and its demands, the situation is mastered and the person behaves and performs well. Various kinds of behaviour with different underlying combinations of competencies are often candidates for mastering a situation; and even more complicated, not only a single but several different behavioural actions can often be appropriate practice.

With a limited number of competencies an 'unlimited' number of different situations can be mastered for the following reasons: (a) different subsets of the same limited set of competencies can become activated in various situations, (b) situations which look different on the surface but are of the same type, may be mastered by the same bundle of competencies. (c) This means, one defining property of a competence is that a transfer of knowledge and action from one situation to another one is possible and also that new problems can be solved by new combinations of existing competencies. (c) The relative stability of competencies makes it possible, that the behaviour of a person is some what predictable and that the person behaves authentically although the situations are different.

Many current measures used in teacher training at the European and the national levels are generally in line with the psychological competence approach. By defining demands for professional teaching, they make it possible enabling to improve the specific action-competence of teachers. However, in view of the above mentioned limitations the methods needed to be developed further in order to clarify the components of competence and of performance in specific teaching situations, their structure and interaction with one another and with the demands of the situations. The so-called *Competence-based Knowledge Space Theory (CbKST)* is an excellent starting point and framework for improving the competence approach in TET.

THE COMPETENCE-PERFORMANCE APPROACH

During the last decade several authors (Doignon, 1994; Düntsch and Gediga, 1995; Gediga and Düntsch, 2003, Korossy, 1997, 1999; see also Albert & Lukas, 1999) independently of each other generalized the *Knowledge Space Theory (KST)* of Doignon and Falmagne (1985, 1999; see also Falmagne et al 1990 for an introduction) for incorporating competencies or skills. An important property of the formalized competence-performance framework is that the behaviour or

performance in a specified situation usually will be guided by a combination of competencies – not only by just a single specific or general competence. The same behaviour and performance may even be 'caused' and activated by one of several adequate combinations of competencies. The framework of competence-performance structure can be used for specifying some implications of the competence-performance distinction for teacher training.

Assessing and comparing competencies: Assessing and comparing competencies is important as well as difficult. In view of European occupational mobility and autonomy of universities and schools, competencies are important in order to:

(a) enable adaptive support of learners in planning individual learning paths,
(b) support learners in navigating through the large body of learning opportunities,
(c) support learners' presentation of accredited achievements and competencies, and
(d) enable universities and schools to identify persons fulfilling the requirements of a specific position.

Assessments and comparisons, however, are not trivial tasks because contents of curricula vary among different schools and universities, and various countries. Thus, when aiming to facilitate TET we must break down competencies into a sufficiently fine granularity on the basis of an underlying model. We have to specify the involved components and assign the observable behavioral acts to specific situations, in order to make specific competencies assessable.

Competence vs. performance: When considering individual competencies the following major problems are often encounted: (a) The unclear differentiation between latent competence and observable performance, (b) the postulated one-two-one mappings of underlying competencies and performances, (c) the usage of the same label for both the competences and the performances (d) usage of various methods for assessment (e.g., observations, tests, achievements) and training (e.g. instructing, exploring, imitating) without analyzing their relationship.

Clear and standardized definitions of competencies in a given domain and a formal structure are required. This allows for distinguishing latent competencies and manifest behaviours and performances in given situations, as well as describing their interrelations.

Competence and performance structures: Knowledge Space Theory (KST) (Doignon & Falmagne, 1985, 1999; Falmagne et al. 1990), and its extensions (e.g. Albert & Lukas, 1999) are the basis for several approaches to competence structures. The extensions provide a set-theoretic framework for organizing a domain of knowledge and representing knowledge based on *prerequisite relationships*. A knowledge domain is represented by a finite set Q of problems, which correspond to the previously mentioned situations. The *knowledge state* of a learner is described by a subset of problems that s/he is able to master. Due to prerequisite relationships among the problems of a domain, not all subsets of problems are possible performance states. If two problems $a, b \in Q$ are in a prerequisite relation $(a,b) \in R$, we can surmise from mastering problem b a master of problem a and assume from failure to master problem a failure to master problem b. As an example, image five problems of the domain of basic algebra, an addition, a subtraction, a multiplication, a division, and an equation. For five problems the set of all possible knowledge states is 2^5; if we assume that addition, subtraction, multiplication, and division are prerequisites for solving equations, not all 32 knowledge states can occur, because it is highly improbable that a student will be able to solve equations but not problems of addition. To account for the fact, that a problem may be solved in various ways and thus may be associated with different sets of prerequisites, the notion of a *prerequisite function* has been introduced. This function is a generalization of a prerequisite relation, and associates a family of subsets of Q with each problem, instead of only one subset.

The collection of possible performance states for a set Q of questions or problems is called a *knowledge structure K*, which in fact is a *performance structure*. One extension, which

incorporates explicit reference to the competencies that are required for mastering the problems of a domain is the Competence-Performance Approach (CPA, Korossy, 1997, 1999). The basic idea of CPA is to assume a basic set *E* of latent (cognitive) competencies that are relevant for mastering the problems of that domain. The *competence state* of an individual is the collection of all available competencies of that person, which can be uncovered by observable performance. Prerequisite relations between competencies establish a *competence structure C*, which contains the possible individual competence states. Utilizing an *interpretation function*, families of subsets of competencies (*competence states*) can be mapped to problems, which can be mastered with the given competencies. The above mentioned performance structure for the set of problems is induced by the assignment of competencies to the problems of a domain.

To illustrate this approach, assume a knowledge domain that is represented by a set of four problems (e.g., test items), *Q = {a, b, c, d}.* Consider the set *E = {V, W, X, Y, Z}* of competencies that are relevant for solving these problems. The prerequisite relations that exist among these

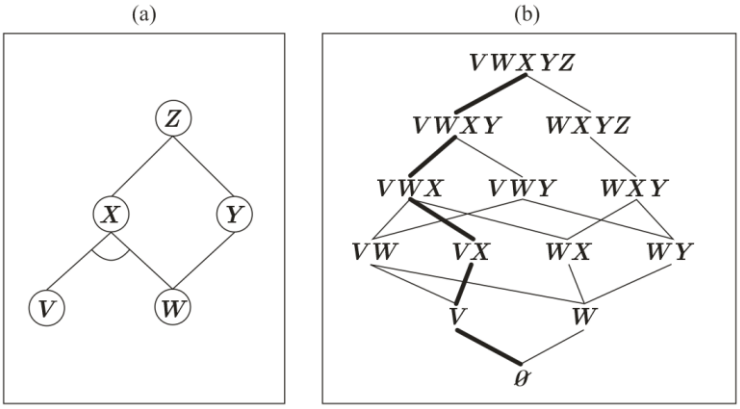

Figure 1. Panel (a) displays an AND/OR-graph for a prerequisite function among five competencies (V to Z). The bended line below competence X indicates a logical or. Panel (b) shows the competence structure established by that prerequisite function. The bold line indicates one valid learning path for competence states.

competences are demonstrated by an And/Or-Graph in Figure 1a. The prerequisite function establishes a competence structure (Figure 1b), which includes only 13 possible competence states from a total of 2^5 combinations and allows for different learning paths. Table 1 lists an interpretation function, which associates competence states that are adequate for mastering a

Table 1. Interpretation function.

Problem	**Competence states**
a	*{V, X}, {W, X}*
b	*{W, Y}*
c	*{V, W, X}, {W, X, Y}*
d	*{W, X, Y, Z}*
.	.
.	.

given problem. This means, for solving problem *a* one of the two competence states *{V, X}* and *{W, X}* is necessary; a student who has one of these two competence states (or a superior one)

will be able to master this problem. Given the interpretation function, the *representation function* specifies the subset of problems that can be solved in each competence state.

Given the performance, i.e. the subset of problems a student can master, the latent (cognitive) competencies underlying that problem solving performance can be identified. Due to the utilization of representation and interpretation functions no one-to-one mapping of performance (e.g., the responses to test items or the behavior in a situation) to competencies is required. It is possible to assess a person's current competence state by personalized, adaptive competence testing and personalized guidance of training. Individual learning paths can be defined on the performance and on the competence level. Competence development along learning paths via individualised learning, teaching and training allows for life long learning.

EXTENSIONS OF THE COMPETENCE-PERFORMANCE APPROACH

Several extensions of CPA have been made or are in progress. These extensions make the resulting CbKST an ideal candidate for improving TET. More specifically these extensions allow for

- distinguishing between required and tested, respectively taught, competencies (Hockemeyer, 2003);
- taking into account more than two evaluation alternatives (Schrepp, 1997) and various adequate behaviours in the same situation (Albert, Pivec et al., 2003);
- defining a competency as a pair of (structured) knowledge content and (structured) action skills (Heller et al., 2006);
- deriving the underlying prerequisite structures from declarative and conceptual knowledge nets (knowledge/concept/semantic nets; Albert & Steiner, 2005a,b) and the underlying skill structure from educational taxonomies (e.g. Anderson, L.W., & Krathwohl, D.R., 2001; Marte et al., in press) and production system models (Schrepp, 1993; Korossy and Held, 2001; Albert & Sternadt, 2006; Albert et al. 2007);
- implementing teaching events and interventions for transforming a person's competence state into another one (e.g. Hockemeyer et al. 1998);
- developing instructional/teaching designs for different didactical approaches (Albert and Hockemeyer, 2002);
- developing methods for describing situations and their demands in terms of ontologies (Heller et al., 2006);
- including, in addition to prerequisite structures, other relationships between the learning and teaching events (Lukas, 1997);
- adapting knowledge and competence structures in dynamic knowledge domains (Albert & Kalascha, 1997) and for life long learning (Kickmeier-Rust, Albert & Steiner, 2006);
- allowing for assessment and acquisition of competencies at the workplace (Ley & Albert, 2003) Ley, Ulbrich, Scheir, Lindstaedt, Kump & Albert, in press);
- supporting peer tutoring (Heller, Hockemeyer & Albert, 2004); and
- integrating the CbKST in a general system for knowledge and competence management (Ley, Albert & Lindstaedt, 2007).

In the following I describe some consequences resulting from the above mentioned extensions for TET.

CONSEQUENCES AND IMPLICATIONS OF THE COMPETENCE-BASED KNOWLEDGE SPACE THEORY FOR TET

CbKST can be applied for describing TET with students, with professors and at an institutional level.

CbKST is of course 'only' a framework, which demands on the one hand to specify the components, events, components and entities which are involved in TET, and on the other hand allows taking use of the postulated structures and derived algorithms for an unlimited number of contents and methods of TET. *By applying CbKST almost all of the above mentioned critical aspects and problems of current TET can be managed.*

Beyond that, CbKST can improve current TET by clarifying some other important questions regarding content and method of TET, among them are the following:

Regarding the contents of teacher training: How to distinguish between competence and behaviour/performance? For instance, analysing and classifying the content of curricula and textbooks according to competence on the one hand and performance on the other, and transforming their content into concrete teaching goals and teaching activities that are important for TET. How to access economically and in detail the competence of a student via his/her behavior and performance? This can be done by applying the CbKST and using the resulting specific structures and the general algorithms developed within CbKST. How to formulate clear, explicit teaching aims and goals, that on the one hand are guide lines for teaching and on the other hand are valid for (self) control of teaching success? How to describe the competencies of an individual to give feedback of results and to prepare a certification? The descriptions have to be done in terms of latent competencies and manifest behaviour, and their interrelationships, in reference to the concrete situations. Which type and content of knowledge and competence is involved (declarative and procedural knowledge; required and tested/taught knowledge; explicit and implicit knowledge; meta-knowledge, control-knowledge and strategic knowledge)?

Detailed, concrete analyses of the required contents, knowledge, methods, skills, actions and (cognitive) processes are necessary as well as analyses of the competence-performance relationships for answering these questions. Moreover, how to teach competencies considering also the emotions and motivations of the students? These questions are still under discussion in the European projects ELEKTRA and 80days about game based learning.

Regarding the methods of teacher training: How to implement personalized assessment and training? The individual student will receive those tailored tasks and interventions which he/she can understand and for which he/she has the required competences. How to define standards? Standards have to be defined by the demands of situations and the respective performances, that enable to infer underlying competencies. Which are the competencies that identify good and successful teachers in a dynamically changing educational world, and which of these must be taught? To answer these questions, the CbKST has to be applied to the professors of TET. How to manage - by appropriate training methods - that the various aspects of knowledge and competence are taught - e.g. to impart not only declarative but also procedural knowledge, and to transform implicit into explicit knowledge? A student should analyze and resolve various (simulated) situations with the aim of activating various subsets of competences - using e.g. virtual environments, video/DVD-record and -feedback, and role playing methods. In general, future and current teachers have to learn professional problem solving. Thus, the necessary specific competencies have to be acquired in appropriate situations. In order to be able to fulfil the required teaching and training demands in a changing world, the students also have to acquire competencies to reduce working load e.g. by applying eTeaching technology and eContent.

And finally, of course, CbKST-oriented TET should cover CbKST as content as well as a method. In order to be able to facilitate the competencies of their students, the professors of TET and the (future) teachers have to be made familiar with the concepts of competence and performance and how to apply them. It is sensible to start by teaching the professors and students involved in TET the principles of CbKST (http://css.uni-graz.at/projects/CbKSTCourse/release/) and their implications for TET.

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