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Competence Description for Personal Recommendations: The importance of identifying the complexity of learning and performance situations

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ABSTRACT

For competences development of learners and professionals, target competences and corresponding competence development opportunities have to be identified. Personal Recommender Systems (PRS) provide personal recommendations for learners aimed at finding and selecting learning activities that best match their needs. This article argues that a clear-cut description of the concept of 'competence' is needed for appropriate system-based personal recommendations. It is proposed to extend current initiatives on standardization of modelling competences with the concept of 'Learning and performance situation' (LP-situation) and it is claimed that this extension has added value for personal recommendations for adequate selection of learning activities, for determining proficiency levels of competences, for the design of learning tasks, and for accreditation of prior knowledge. Advantages and disadvantages are discussed.

Keywords

Competence description, learning and performance situations, personal recommender system

The concept of *competence* is strongly associated with post-secondary education (e.g., Mulder, Wesselink, Biemans, Nieuwenhuis, & Poell, 2003; Stoof, Martens, & Van Merriënboer, 2007; Westera, 2001) as well as professional development (e.g., Eraut, 1994). Many work organisations and educational institutes use the concept of 'competence' for describing performance ability for particular occupations or jobs or for describing educational objectives. For instance, in the Netherlands, the competence requirements of good quality teachers are classified in seven competences: interpersonal competence, pedagogical competence, subject knowledge & methodological competence, organizational competence, competence for collaboration with colleagues, competence for collaboration with the working environment, and competence for reflection and development (SBL, 2004). Similarly, psychology students of the Open University of the Netherlands have to acquire three competences: (1) research competence, (2) diagnosis competence, and (3) intervention competence.

For competences development of learners and professionals, target competences and corresponding competence development opportunities have to be identified. Thereupon, learners may acquire the target competences by participating in so-called Competence Development Programs (CDPs). A CDP is an ordered set of learning activities, either formal or informal, that are used to build competence in a certain discipline or job (Herder et al., 2006; Koper, 2006). An example of a CDP is a sequenced set of courses to be followed in order to get a Master of Science degree in psychology. Currently, many formal and informal CDPs exist, from different educational institutes and communities of practice, at different levels of proficiency, and situated in different disciplines, domains or job settings. Finding and choosing an appropriate CDP is not that easy for learners. The CDP has to match learners' individual competence goals (e.g., MSc in Psychology), and their personal preferences (e.g., study location, didactical methods). Also, the course entry requirements should match learners' already acquired competence profile (e.g., bachelor degree in psychology). Many learners do not have the adequate skills to find out which CDPs are offered and which are appropriate. Thus, these learners need to be supported when looking for an appropriate CDP. Within educational institutes, study advisers can be consulted for this, but when choices concern learning activities of more than one educational institute or even outside institutes, advice is scarce. Recently, Personal Recommender Systems (PRS) for learners are developed for that purpose. A PRS provides personal recommendations for learners aimed at finding and selecting CDPs that best match their needs (Drachsler, Hummel, & Koper, in press; Van Setten,

2005). In an information-based PRS for learners, information concerning desired and acquired competence profiles are combined (Hummel et al, 2007).

In order for a PRS to provide personal recommendations for a learner, a *competence description* is needed that enables comparison of information concerning individual target competences and acquired competences on the one hand, and CDP-related information on the other. In this article, first the current competence descriptions will be described and examined for their usefulness for PRSs. Second, the term *context* will be conceptualized and the term *learning and performance situation* (LP-situation) will be introduced. It is argued that relevant *complexity factors* typify a LP-situation. Third, advantages and disadvantages of including LP-situations and, consequently, complexity factors, in characterizing CDPs are addressed. We claim that, although valuable for its purpose, current competence descriptions should be extended with a description of the LP-situation. An adjusted, augmented competence description, including LP-situations, is suggested. Fourth, an example of a CDP selection problem is presented that demonstrates how PRSs can benefit from an augmented competence description. In the last section of this article, implications of our claim will be discussed.

Current competence descriptions

The concept of competence can have quite different connotations and definitions (Cheetham & Chivers, 2005; Stoof et al., 2002; Van Merriënboer, Van der Klink, & Hendriks, 2002; Westera, 2001). It should also be noted that there is a distinction in the literature between the term 'competence' and the term 'competency' (De Coi et al., 2006; Eraut, 1994). Competence is given a generic or holistic meaning and refers to a person's overall capacity whereas competency refers to specific capabilities (knowledge, skill, attitude, ability). Cheetham and Chivers (2005) offer the following rather general definition of competence:

> Effective overall performance within an occupation, which may range from the basic level of proficiency through the highest levels of excellence.

Stoof et al. (2002), on the other hand, postulate that the meaning of the concept of competence is very unclear. They give a short overview of recent history of 'competence' and provide examples of current definitions, such as "a cluster of knowledge, skills and attitudes" or "the ability to handle a situation". Stoof and colleagues conclude that it is useless to look for the true definition of competence and argue that everyone may construct their own competence definition instead, as long as it is viable. Viability of a competence definition increases when it is clear what the representations and opinions about competences are of the people who construct the competence definition. In addition, the goal of the competence definition should be made clear in order to construct a suitable and useful definition. Finally, it should be clear who the intended users of the definition are (Stoof et al., 2002).

However, idiosyncratic definitions of competence are insufficient for enabling system-based personal recommendations for selecting adequate CDPs. These recommendations could be based on learners' needs (i.e., their competence goals), their preferences (e.g., preferred study mode, preferred learning style, preferred delivery mode, preferred task characteristics such as performance situation), and CDP-related information. Thus, for personal recommendations, retrieval, exchange and reuse of learning units for international educational institutes is needed. A learning unit refers to each unit where learning can take place, and it can be large or small. Examples are a course, a module, and a CDP. For an effective exchange of learning units, educational institutes need to use a common format of competence description. In the same vein, a common format of competence description is needed when educational designers aim to design formal CDPs that could be used and reused by international educational institutes. These designers of CDPs, as well as the users of the programs, need to know what learners should be able to do when learners have completed a CDP, that is, which competences should be acquired in the CDP. Thus, designers should make sure that they explicitly describe the necessary elements of the competence aimed at in the designed CDPs. Moreover, learners want to know what competences are needed for a particular job (the so-called job profile or required competence profile), what competences they already have acquired (their acquired competence profile, e.g., accreditation of prior learning), what competences still have to be acquired (their competence gap profile), and where to find existing CDPs to reduce the gap between the acquired competence profile and job profile. For the goals of learners, educational designers, and educational institutes, a sound competence description or model that specifies all relevant ingredients is needed.

Some valuable initiatives on standardization of modelling competen*cies* exist, such as those of IMS RDCEO (2002), IEEE-RCD (2006), and HR-XML (2006). The main purpose of these initiatives is to enable interoperability among learning systems that deal with competency information by providing a means for them to refer to common definitions with common meanings. Central repositories are build that define competencies and these competency definitions can be referenced by external data structures. All three definitions include titles and descriptions that need to be interpreted by human beings. Furthermore, the objective of these descriptions is to represent formally the key characteristics of a competency, independently of its use in any particular context or environment. Thus, these approaches to modelling competencies exclude 'context' from their definitions, because when information concerning context becomes part of the competency definition, its reusability is drastically reduced (De Coi et al., 2006). On the other hand, when selecting an adequate CDP, the context to which a CDP refers to may be very important to the learner. For instance, a professional teacher who wants to develop her teaching competences may particularly look for urban, cross-cultural work situations. Thus, for adequate recommendations, PRSs should be able to retrieve and exchange information concerning context. Several theorists (e.g., Sandberg, 2000) argue that competences used in accomplishing work are not primarily context-free but are situational, or context dependent. Also Koper (2006), in his definition of competence, links competence to context or situations, by him labelled as 'ecological niche' (an occupation, a hobby, a market, a sport, etc.). We conclude that context is an important element related to competence and that context should be modelled. In order to maximize reuse, competence and context should be considered as different dimensions that should be modelled separately (De Coi et al., 2006).

Conceptualizing context

Tessmer and Richey (1997, p. 87) define context as "multilevel body of factors in which learning and performance are embedded". Context is thus perceived as the simultaneous interaction of a number of mutually influential factors. The multi-level nature of context means that different spatial and temporal levels of contexts need to be considered, such as the immediate and surrounding contexts.

According to Cheetham and Chivers (2005), a person could be extremely competent in one particular context, but becomes much less so if the context or environment changes. For instance, a teacher in primary education can feel highly confident in his ability to control a class of a rural town school, but a definite lack of confidence when supposed to control a class of a school in a big city. Here, both contexts ask for similar competences (e.g., 'interpersonal competence'), but one would agree that the latter 'context' is much more complex. This difference in complexity is determined by several complexity factors, such as class size or social economic background of learners and parents. In the revised competence model of Cheetham and Chivers (2005), context of work has an important place. They define context of work quite generally as 'the particular working situation in which an individual is required to operate'. Also Van Merriënboer, Van der Klink and Hendriks (2002) argue that competences are context-specific. They examined several competence definitions, representing eleven approaches to competences. Nearly all approaches that were mentioned in the study of Van Merriënboer et al. emphasized the context-specificity. That doesn't mean, however, that all theorists perceived 'context' the same way. As a matter of fact, Van Merriënboer et al. concluded that 'context' is hardly defined at all. According to De Coi et al. (2006), modeling context may be a complex task, as it may coincide with a whole domain. So are we replacing the problem of defining competence by the problem of defining context? Not really. We argue that identifying the most relevant *complexity factors* to typify a 'context' could make the concept of 'context' valuable and usable for exchange and reuse.

Instead of 'context', we prefer the term *learning and performance situation* (LP-situation) for two reasons. First, 'context' can refer to very abstract or concrete notion of circumstances such as (1) a culture or environment (e.g., a school in a suburb), (2) types of situations (e.g., classes with medium class size and children of two cultures, with complexity factor class size set to medium and complexity factor cultural diversity set to two), and (3) to very specific cases (e.g., a particular class with John, Paul, George, Mohammed, Ahmed, …). It is the middle level of abstraction, that is, types of situations that we consider to be appropriate for reuse. Second, we like to speak of '*learning and performance* situation' rather than of 'work situation' or just 'situation'. In education as well as in professional development, the actions learners perform when acquiring competences can also refer to other situations then situations directly related to work or occupations whereas such actions can still be very important for the acquisition of relevant competences. These other situations may have a lot of characteristics in common with the work situations, though.

Advantages and disadvantages of identifying complexity factors

LP-situations are considered to be typified by interplay of various complexity factors. Including LP-situations and, consequently, complexity factors, in characterizing CDPs has advantages as well as disadvantages. The first, and most important advantage, is that by including LP-situations in characterizing CDPs, personal recommendations can be *tuned* to the needs of the learner and the learner will be confronted with most relevant tasks when actually participating in a CDP. Although educational institutions nowadays provide descriptions of competences and sometimes descriptions of critical or characteristic job situations, these descriptions of job situations are generally very shallow and lack a systematic approach such as we propose in our LP-situation concept. Second, LP-situation may support the determination of the *proficiency levels* of competences which are used within a competence specification/standard. Third, a series of LP-situations and the complexity factors within it, ranging from relatively easy to complex, may be very helpful for the *design* of learning tasks. Fourth, descriptions of relevant performance situations may be useful for *accreditation of prior knowledge*. As our approach makes it possible to have an unequivocal mapping from LP-situation to proficiency levels within a competence specification standard, one can argue that LP-situations comply with the need to be able to exchange learning units between CDPs. Consequently, any lifelong learner will benefit from a competence description using LP-situations.

A disadvantage of the inclusion of LP-situations in competence descriptions could be that it makes a competence description more complex. Moreover, agreement between stakeholders (learners, educational institutes, professions and even politicians) concerning the relevant LP-situations and the corresponding complexity factors should be established. This will probably impede the debate and negotiation with respect to competences and proficiency levels for domains, whereas already existing agreements on competence maps need to be extended with LP-situations.

We will illustrate our claims with an example. Imagine that a learner wants to learn how to ride an All Terrain Bike (ATB) in all circumstances. In Table 1, the already acquired competence profile, the target competence profile and the complexity factors of LP-situations are specified. The already acquired competence profile refers to the collection of a person's already acquired competences that are relevant for the competence goal. The desired competence profile refers to the collection of relevant competences the person needs to achieve for proving he/she has reached the competence goal. LP-situations are created by combining several levels of relevant complexity factors. In this example, with four complexity factors that all have two levels, sixteen different LP-situations are distinguished.

Table 1. Use case riding an All Terrain Bike (ATB) for a learner with a specific goal and preferences

Goal:	I want to be able to ride an ATB in all circumstances
Acquired competence profile:	I can ride an ATB on a paved, quiet, and flat place when the sun is shining:
Desired competence profile	I can ride an ATB when descending an unpaved mountain highway during a traffic peak and heavy rainfall
Complexity factors:	a. surface structure of the road
	b. amount of traffic on the road
	c. shape of the road
	d. weather conditions
Values for complexity factors:	a. surface structure of the road (paved, unpaved)
	b. amount of traffic on the road (quiet, peak)
	c. shape of the road (flat & straight, hilly & curved)
	d. weather conditions (bright & sunny, heavy rain)
Preferences for the learner:	I can maximally spend 20 hours a week on training

As can be seen from Table 1, by considering LP-situations in characterizing CDPs, personal recommendations can be tuned to the needs of the learner (first advantage), and the learner will be confronted with most relevant tasks when actually participating in a CDP. In our example, a personal recommendation system will search for CDPs that – in the end - include *cases* (most specific level of abstraction) for riding an ATB on unpaved, hilly and curved roads, during traffic peaks and during heavy rainfall which will not exceed spending maximally 20 hours a week in training sessions. A case is considered as an *instantiation* of a LP-situation, including an assignment or task. At the level of concrete learning materials included in the CDP, this could be a case on descending the road safely just outside Adis Abeda at 8 o'clock in the morning during the rainy season, but it could also be a case on the Karakoram

Highway just near the border with Pakistan on a Friday afternoon during the rainy season, or a case on descending safely from the suburbs on the Altiplano to the center city of La Paz at 7 o'clock in the evening during the rainy season. The identification of LP-situations, including complexity factors, makes it possible that learners will be recommended with gradually more complex CDPs. This increases their chance of acquiring their goal (e.g., Van Merriënboer, 1997).

LP-situations can also support the determination of the *proficiency levels* of competences within a competence specification/standard (second advantage). Educational institutes as well as work organizations use different idiosyncratic scales to represent proficiency level, but they are often arbitrary, because the grounds on which the standards for each proficiency level are determined are very often unclear (Eraut, 1994). We suggest using the complexity factors and their scales within LP-situations for the determination of proficiency levels. For instance, a learner could very well ride an ATB on a paved quiet road, but not on an unpaved road during peak hours. Similarly, a teacher could very well act effectively in a situation in which s/he has to instruct ten students without learning problems. However, the same teacher may fail to act adequately in a situation in which s/he has to instruct thirty students with learning problems. These two situations differ concerning the 'number of students' and the 'number of students with learning problems'. These two complexity factors, in fact, determine the LP-situation. The values of these complexity factors in a specific situation could very well determine the proficiency level on which a teacher can act effectively. By combining the complexity factors, one could create a scale of several levels of proficiency. For instance, a combination of two complexity levels of complexity factor A (values a and A) and two complexity levels of complexity factor B (values b and B) results in four different complexity levels (ab, Ab, aB, and AB), creating a scale with three or four proficiency levels. When several complexity levels can be identified, as is the case in job situations of teachers, and when these factors have more than two levels, the number of proficiency levels may increase very fast. It is therefore suggested not to just determine and rank proficiency levels but also to explicitly describe proficiency levels in terms of complexity factors. This issue will be addressed when a worked out example is presented at the end of this article.

Third, performance complexity characterized via complexity factors may be helpful for the design of learning tasks and CDPs (third advantage). In his 4C/ID-model, Van Merriënboer (1997), advocates a whole-task approach of instruction. In a whole-task approach, the learner is taught all constituent skills at the same time, but conditions under which the whole skill is trained become more complex during the training. Conditions that may simplify the performance of a complex skill, that is, complexity factors, must be identified in order to create authentic cases that differ in complexity. A learner starts with the simplest authentic case that a professional may encounter. During the training, the simplifying conditions should be relaxed one at a time, so that the cases for instruction become more and more complex. For instance, suppose that a novice teacher in training wants to work on her 'competence for collaboration with the working environment'. For this, she must, among other things, keep in touch with students' parents or guardians, give them professional information, and use the information she gets from them. Authentic cases that differ in complexity must be created, for instance cases in which the teacher in training has a meeting with student's parents. Complexity factors for such an authentic case could be: (1) the possibility of learning problems of the student, (2) the possibility of social problems of the students, (3) the social skills of the parents, and (4) whether the student joins the meeting between teacher and parents. In our view, a novice teacher in training should start practicing with an authentic case in which she meets socially skilled parents of a student without learning and social problems, with the student being absent. Thus, all complexity factors should be set on the simplest option. In that relatively simple authentic case, the teacher in training can practice all the skills, procedures and scripts that are relevant for adequate performance. During training, the complexity factors can be set to a more complex value one at the time. It should be noticed that for every case, no matter how complex, learners should meet similar performance criteria. For instance, in all cases concerning meetings with parents or guardians, the teacher should be able to (1) explicit the goal of the meeting, (2) provide relevant information to the parents, (3) get relevant information from the parents, (4) sustain a good relationship with the parents, and (5) make appointments for future activities. At the Open University of The Netherlands, a large set of job situations and learning tasks for teachers were designed based on variation of complexity factors (Proformas, 2008).

Fourth, it is increasingly acknowledged that part of the learning does not take place in formal but in non-formal and informal situations. When enrolling formal education, for instance Psychology at the Open University of the Netherlands, learners may already have acquired competences in informal situations that are also part of the formal CDP (i.e., curriculum offered by the Open University of the Netherlands). But how could accreditation of prior learning be reached? What information should the learners provide in order to convince the Psychology institute of

the fact that the learner has already acquired relevant competences? We suggest that the LP-situation, mapped towards a competence specification/standard, may function as the missing link between informal learning and formal accreditation (fourth advantage). For instance, an individual who has been a volunteer counselor for Kids Help Phone received an informal training and has a lot of experience with counseling conversations. The instantiations of the LP-situations in which the individual acted effectively, that is, particular cases, show many similarities with the LP-situations in which a clinical psychologist could be involved, including roles and performance indicators. When this is the case, the learners may be considered for exemption for some modules of the clinical psychology curriculum.

Thus, in our opinion, professionals and educational institutes should describe their LP-situations when characterizing their CDPs. It is interesting to notice that some initiatives are aimed at describing characteristics of situations in which professionals are supposed to perform. For instance, the Occupational Information Network (O*Net, http://online.onetcenter.org/) is a comprehensive database of worker attributes and job characteristics. O*NET is being developed as a timely, easy-to-use resource that supports public and private sector efforts to identify and develop the skills of the American workforce. It provides a common language for defining and describing occupations. Its flexible design also captures rapidly changing job requirements. Part of O*Net is a description of work context. Work context of occupations is determined by a 57 item questionnaire in which several dimensions of work context are listed, for instance, contact with others, responsibility for health and safety, conflict situations, and telephone conversations. Many of these items refer to work conditions (temperature, body vibration, radiation) but some of the 57 items can be used for a description of a LP-situation, as long as it concerns a relevant complexity factor for the particular job or occupation. Note that a complexity factor must be a variable that, depending on its value, makes performance for a professional in his or her job, more simple or complex.

Thus, in the proposed competence description, competence is linked to proficiency level, which, in turn, is determined by complexity factors of several LP-situations. Evidence of acquired competences will be based on performance in instantiated LP-situations, that is, in cases of particular complexity. In our view, a competence description that is useful for a PRS contains the elements that are specified in Table 2.

Table 2. Elements of a competence description

No.	Name	Explanation	Reqd	Mult	Type
0	Competence description	This element specifies the competence description.	-	-	Sequence
0.1	*Identifier*	A unique label that identifies this competence description (ID).	M	1	ID
0.2	Title	A single text label for the competence description. This is a human-readable name for the competence. The title may be repeated in multiple languages.	O	0..1	String
0.3	Description	A human-readable description of the competence. Unstructured string meant to be interpretable only for humans. The description may be repeated in multiple languages.	O	0..1	String
0.4	Definition	A structured definition of the competence description.	O	0..1	String
0.5	Learning-Performance-Situation-ref	Refers to a learning performance situation.	O	0..*	Sequence
0.6	Complexity-Factor-ref	Refers to a complexity factor.	M	1..*	Sequence
0.7	Proficiency-Level-ref	Refers to a proficiency level.	M	1	Sequence
0.8	Performance-Indicator-ref	Refers to a performance indicator.	O	0..1	Sequence
0.9	Mapping-function	Description of how the multiple values of the complexity variables are mapped towards all single-value proficiency levels. All possible combinations should be mapped towards a proficiency level and all possible values for proficiency level should be used at least once.	O	0..1	String
0.10	Metadata	Placeholder for metadata. Include IMS Meta-Data here, using its namespace.	O	0..1	Sequence

Learning-Performance-Situation					
No.	**Name**	**Explanation**	**Reqd**	**Mult**	**Type**
0	Learning-Performance-Situation	This element contains a sequence of elements for learning and performance situations definitions.	O	0..*	Sequence
0.1	*Identifier*	A unique label that identifies this learning performance situation.	M	1	ID
0.2	Title	A single text label for the learning and performance situation. This is a human-readable name for the learning and performance situations. The title may be repeated in multiple languages.	O	0..1	String
0.3	Description	A human-readable description of the learning and performance situation. Unstructured string meant to be interpretable only for humans. The description may be repeated in multiple languages.	O	0..1	String
0.4	Definition	A structured definition of the learning and performance situations.	O	0..1	String

Complexity -Factor					
No.	**Name**	**Explanation**	**Reqd**	**Mult**	**Type**
0	Complexity-Factor	This element contains a sequence of elements for complexity factor definitions.	M	1..*	Sequence
0.1	*Identifier*	A globally unique label that identifies the complexity factor.	M	1	ID
0.2	Title	Text label of the complexity factor that has impact on the complexity of a learning and performance situation.	O	0..1	String
0.3	Description	Description of the complexity factor that has impact on the complexity of a learning and performance situation.	O	0..1	String
0.4	Definition	A structured definition of the complexity factor.	O	0..1	String
0.5	**{itemvalue}**	Schema group that enumerates the possible values of each complexity factor.	M	1	Group

Proficiency-Level					
No.	**Name**	**Explanation**	**Reqd**	**Mult**	**Type**
0	Proficiency-Level	This element contains a sequence of elements for proficiency level definitions.	M	1	Sequence
0.1	*Identifier*	A globally unique label that identifies the proficiency level.	M	1	ID
0.2	Title	Text label of the proficiency level.	O	0..1	String
0.3	Description	A human-readable description of the proficiency level.	O	0..1	String
0.4	Definition	A structured definition of the proficiency level.	O	0..1	String
0.5	**{itemvalue}**	Schema group that enumerates the values of the proficiency levels.	M	1	Group

Performance-Indicator					
No.	**Name**	**Explanation**	**Reqd**	**Mult**	**Type**
0	Performance-Indicator	This element contains a sequence of elements for performance indicator definitions.	O	0..1	Sequence
0.1	*Identifier*	A globally unique label that identifies the performance indicator.	M	1	ID
0.2	Title	Text label of the performance indicator.	O	0..1	String
0.3	Description	A human-readable description of the performance indicator.	O	0..1	String
0.4	Definition	A structured definition of the performance indicator.	O	0..1	String
0.5	**{itemvalue}**	Schema group that enumerates the values of the performance indicators.	O	1	Group

{itemvalue}					
No.	**Name**	**Explanation**	**Reqd**	**Mult**	**Type**
0	Itemvalue	A schema group for values.	-	-	Sequence
0.1	*Identifier*	A globally unique label that identifies the item.	M	1	ID

0.2	Title	Text label of the item.	O	0..1	String
0.3	Values	List of values (separated by commas) that can be used.	M	0..1	String
0.4	Datatype	The data type of the item. Possible values: string, boolean, integer, real	M	1	Token
0.5	Scale-type	Type of the scale used. Possible values: ordered, ratio	O	1	Token
0.6	Min-value	Minimum possible value.	O	1	String
0.7	Max-value	Maximum possible value.	O	1	String

An example of a CDP selection problem

To illustrate the claims above, in this paragraph an example of a CDP selection problem is presented. The example is based on the competence requirements for teachers, defined by the Association for the Professional Quality of Teachers, SBL (SBL, 2004). Imagine that a young teacher wants to acquire the *competence for collaboration with the working environment* of a teacher in pre-higher education. There are many CDPs around in several educational institutes for attaining this competence goal. The young teacher decides to consult a PRS. Besides using personal preferences within PRS, additional input for the PRS is the already acquired competence profile, consisting of relevant certificates as well as experiences in relevant job situations, and the desired competence profile. The experiences in relevant job situations may very well be matched with LP-situations with several values of corresponding complexity factors. Which of the LP-situations is the young teacher familiar with? In which of the LP-situations, including values of corresponding complexity factors, was the young teacher successful? Similarly, the young teacher can identify in which of the LP-situations, including values of corresponding complexity factors, wants the young teacher to be successful. It is probably exceptional when the young teacher knows exactly what his desired competence profile is, but also incomplete information about the desired competence profile can put the PRS to work. It is possible when the PRS provides recommendations, the desired competence profile may become clearer to the young teacher. In our example, the young teacher wants to perform adequately in the LP-situation *planned meetings with parents* of students with social problems.

After the young teacher's input of information concerning acquired and desired competence profile, as well as personal preferences, the PRS will search for CDPs that match personal needs, preferences, and competence profiles. Subsequently, the PRS recommends and provides access to possible cases, that is, possible learning activities in instantiated LP-situations with determined values of complexity factors, available at different educational institutes. In order to do so, a competence description is needed in which LP-situations, with corresponding complexity factors, are identified. In Table 3, an overview of a possible competence description of this example is presented, including proficiency levels, performance situation, complexity factors and values. In this example, the possible itemvalues of the complexity factor "social problems of the student" are 0 (student has no social problems) and 1 (student has social problems). The combination of itemvalues of the relevant complexity factors determines the difficulty of LP-situations. In our example, there are four relevant complexity factors (i.e., the possibility of learning problems of the student, the possibility of social problems of the students, the social skills of the parents, and whether the student joins the meeting between teacher and parents). The second complexity factor is described in Table 3. Furthermore, the combination of itemvalues of the four relevant complexity factors requires a mapping towards the allowed proficiency levels. For instance, when a learner cannot perform adequately in a LP-situation in which the values of the four relevant complexity factors are 0, the corresponding proficiency level may become 1 (novice). When a learner performs adequately in a LP-situation in which the values of the four relevant complexity factors are 0, but not adequately in a LP-situation in which at least one of the values of the complexity factors is 1, the corresponding value of the proficiency level may become 2 (advanced beginner), as is illustrated in the example. Similarly, when the learner performs adequately in a LP-situation in which the values of the four relevant complexity factors are 1, the proficiency level may become 5 (expert). More intermediate levels can be determined accordingly. The higher the number of complexity factors or the higher the number of levels of a complexity factor, the more proficiency levels are possible and the more important it is to have a good mapping between values of complexity factors and proficiency levels. For instance, suppose that in a LP-situation complexity factor A has possible values (a1, a2), complexity factor B has values (b1, b2) and complexity factor C has values (c1, c2). All possible combinations (a1, b1, c1), (a1, b1, c2), (a1, b2, c1), (a1, b2, c2), (a2, b1, c1), (a2, b2, c1), (a2, b1, c2) (a2, b2, c2) at the one side and proficiency levels at the other should be mapped. When there are less than nine proficiency levels allowed (and we believe that nine proficiency levels are too many), it should be made clear how these nine combinations are mapped

towards a limited set of proficiency levels (four in our example). Thus, the determination of a limited set of proficiency levels should be based on an explicit rule or description.

In Table 3, one LP-situation is described in terms of complexity factors and performance indicators. The example aims at illustrating our claims and is thus not a complete description of this competence. That means that other LP-situations as well as complexity factors can be added to the example. One competence can refer to many LP-situations, and many complexity factors may determine a LP-situation. Therefore, it is important to reduce the number of LP-situations and the number of complexity factors.

The identifiers and itemvalues of proficiency levels and the complexity factors corresponding to a LP-situation, can be input for PRSs. When the young teacher in our example wants to find cases at proficiency level 2 (advanced beginner) to develop the competence for collaboration with the working environment of a teacher in pre-higher education, the PRS system selects cases (instantiations of LP-situations) corresponding to proficiency level 2, that is, it selects instantiations of LP-situations of which, for instance, only one complexity factor has the value 1 and three have the value 0. The young teacher can be considered to be at proficiency level 2 when adequate performance is shown in cases corresponding to LP-situations of proficiency level 2.

This example illustrated the first, second and fourth advantage of matching LP-situation to a competence description. In order for the PRS to select appropriate CDPs based on LP-situations and complexity factors, learning activities (cases)and CDPs should be designed based on a variation of these LP-situations. These LP-situations and complexity factors are helpful for the purposes of competence descriptions that we described above.

Table 3. Example of a competence description

	Name	**Explanation**
0	CompetenceDescription	
0.1	*Identifier*	
0.2	Title	Competence for collaboration with the working environment
0.3	Description	The teacher in pre-higher education must keep in touch with the students' parents or guardians, and with colleagues of educational and youth welfare institutions his/her school collaborates with. He/she must make sure that his/her professional actions are in line with those of others outside the school. Furthermore, he/she must contribute to a good development of collaboration between his/her school and the institutions concerned.
0.4	Definition	The teacher in pre-higher education must keep in touch with the students' parents or guardians, and with colleagues of educational and youth welfare institutions his/her school collaborates with.

0.5	Learning-Performance-Situation	
0.5.1	Title	Planned meeting with parents or guardians
0.5.2	Description	In a planned meeting, a teacher meets with student's parents or guardians to discuss cognitive, social, and/or affective progress of the student. The teacher gives parents and other parties involved professional information about the students, and uses information the teacher gets from them.
0.5.3	Definition	In a planned meeting, a teacher meets with student's parents or guardians to discuss cognitive, social, and/or affective progress of the student.

0.6	Complexity-Factor	
0.6.1	*Identifier*	
0.6.2	Title	Social problems of student
0.6.3	Description	The student has social problems, such as aggressive behavior in school, …
0.6.4	Definition	The student has social problems.

0.7	Proficiency-Level	
0.7.1	*Identifier*	
0.7.2	Title	Advanced beginner
0.7.3	Description	Performs adequately in for this competence relevant learning and performance situations in which all four complexity factors have the least complex value.
0.7.4	Definition	Performs adequately in for this competence relevant learning and performance situations in which all four complexity factors have the least complex value.
0.8	Performance-Indicator	
0.8.1	Title	Explicit goals of meeting
0.8.2	Description	The teacher explicits the goal of the meeting by giving relevant information concerning characteristics of the student
0.8.3	Definition	The teacher explicits the goal of the meeting

Discussion and conclusion

In this article, it was argued that a clear-cut description of the concept of 'competence' to characterize CDPs, individuals' acquired and target competence profile, is needed for system-based personal recommendations for selecting appropriate CDPs. We proposed to extend current initiatives on standardization of modelling competencies with the concept of 'LP-situation' and claimed that this extension has added value for personal recommendations for adequate CDP selection, for determining proficiency levels of competences, for the design of learning tasks, and for accreditation of prior knowledge. With an adequate CDP, at the right proficiency level, that is, consisting of LP-situations with values for complexity factors that match learners' prior knowledge and desires, learners can acquire competences in a more efficient, less frustrating way. Therefore, competence descriptions, CDPs, LP-situations with values for complexity factors and proficiency levels for competences should be clearly defined. Moreover, an educational technological system such as a PRS should be able to deal with the extensive information concerned with competence descriptions, CDPs, and LP-situations.

This leads to the question how and by whom the LP-situations should be designed. We suggest that professionals and educational institutes should collaboratively describe LP-situations for their domain in a systematic way, including complexity factors and their possible values, and, for each competence agree on the mapping towards proficiency levels. In the Netherlands, the Association for the Professional Quality of Teachers (SBL, 2004) succeeded in agreeing on the competence requirements for teachers. The next step is to agree on a systematic description of LP-situations. Further research is needed to examine whether professions are willing and able to add LP-situations and corresponding complexity factors to job descriptions and competence requirements. Moreover, research is needed to determine methods and procedures for communities of practitioners to define characteristic LP-situation with corresponding complexity factors. Special tools, such as the web-based support for constructing competence maps of Stoof et al. (2007), could be designed or adjusted for explicit support concerning systematic description of LP-situations.

Not all competences are equally context-specific (Van Merriënboer et al., 2002). Some competences are applicable to many LP-situations of many domains (e.g., social competence) and others are limited to a specific domain or to a few characteristic LP-situations. Consequently, general competences can be linked to many LP-situations, and thus, learners almost have an unlimited choice of LP-situations that can be used to develop this general competence. On the other hand, many relevant but domain-independent LP-situations could make it more difficult to distinguish a limited number of proficiency levels. It is a challenge for educational designers to select the appropriate LP-situations in a particular domain. For practical reasons, the number of relevant complexity factors and their possible values should be limited; otherwise many proficiency levels could be distinguished. It is open to discussion how many complexity factors and how many values for each of them are relevant to distinguish. Suppose one already agreed to distinguish between, lets say, three proficiency levels, then one needs to specify how the complexity factors and their possible values will be mapped towards those three proficiency levels. If the acquired competence profile would equal level one and desired competence profile would equal level three, personal recommendations would firstly offer CDPs that aim at level two. Often, the model of Dreyfus (2000) is used, in which five proficiency

levels are described. In our opinion, each of these levels should be described in terms of LP-situations, which makes the proficiency levels concrete and attainable.

After agreement about the LP-situations and the complexity factors in the community of practitioners, technology should come in to define the competences in terms of the current initiatives such as RDCEO, HR-XML, and IEEE RCD and link these definitions to modeled LP-situations. In fact, we propose to add extensions for LP-situations to these initiatives in a way similar as is suggested by Sampson, Karampiperis, and Fytros (2007). In this way, our approach towards competence description complies with existing initiatives for referencing and exchanging competences between learning systems, human resource systems, and competency or skill repositories (De Coi et al., 2006).

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