A Competence Perspective on the Occupational Information Network (O*NET)

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Abstract

*The purpose of this paper is to develop a conceptual model which integrates the well-established US-based occupational information network (O*Net) into a competence perspective. Taking serious claims about lifelong learning, one of the biggest challenges is the assessment of tacit knowledge and competences. To tackle this challenge, we depart from four well-established competences (personal competence, social competence, methodic competence and domain competence), and integrate descriptors from the O*Net. We argue that learning outcomes (what a person should be able to do) can be made comparable and accessible when linking them with the descriptors from the O*Net. This approach is in line with the European Qualification Framework (EQF), that aims at establishing comparability of learning outcomes within the European Union and relies on theories linking individual to organizational learning.*

1. Introduction

1.1. Lifelong learning

The political agenda in Europe puts a strong emphasis on lifelong learning [19]. But, if learning happens outside of institutional frames [3,4], and is mainly experientially, the question is, how do we assess the *learning outcomes*? How can we identify and validate tacit knowledge and competences? And how can we ensure, that people who perform in a certain job do so on high quality, even if they did not go through formal education?

The purpose of this paper is to introduce a conceptual model to integrate *learning outcomes* that are formulated in the European Qualification Framework (EQF) [20], an attempt to standardize European professional education, with *descriptors* from the O*Net [24], a large database that offers a taxonomy for all occupations established in the US. It is not our intent to place one approach over the other, rather we aim at investigating how they enrich each other.

While the European competence perspective is action oriented and thus normative [9,21], the O*Net taxonomy is rather descriptive. While the competence perspective provides a view on what *people who perform a certain job should be able to do*, and thus emphasizes quality requirements, the O*Net offers a comprehensive list of relevant occupational descriptions. This paper integrates these perspectives to gain the advantages of both approaches. By integrating a normative competence model and the descriptive O*Net taxonomy into a coherent framework that translates competences into measurable indicators from industrial and organizational psychology, we aim at providing a framework to assess competences.

This is even more important as competence is a fuzzy concept with no agreed definition [17, 34]. In psychology, competence describes the "ability to exert control over one's life, to cope with specific problems effectively, and to make changes to one's behavior and one's environment, as opposed to the mere ability to adjust or adapt to circumstances as they are" [31]. The competence movement in psychology took of after the claim to test for competence rather than intelligence in educational and occupations situations [18], as cognitive intelligence was seen to be a poor predictor for job performance.

In the field of business and management, [15, p. 202] define competence as a "bundle of skills and technologies rather than a single discrete skill or technology". The competence based view of the firm [13] asserts that firms have to make use of their

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resources [33] but also need to use them in an efficient way in order to gain a competitive advantage. In this regard, competences also play a major role in organizational learning, which can be defined as "a change in the organization that occurs as the organization acquires experience. [...] [it is] a change in the organization's knowledge that occurs as a function of experience" [2].

1.2. Research gap and research question

Competence modelling is often used by firms to define what knowledge, skills, abilities and other characteristics (KSAOs) a person should have in order to perform an occupation successfully [8,27]. However, [27] remark, that, even passed by the top management teams, these kinds of competence models are often arbitrary and seldom translated into measurable job analysis approaches. The problem (and opportunity) with such typical competence modelling procedures is that they have to be blended with thorough job analysis approaches [8,27] from industrial and organizational psychology.

Furthermore, as the O*Net exerts a major influence on competence frameworks around the world, it should be taken into account in the European competence frameworks [35, p. 685].

Reviewing the relevant literature, we are not aware of a model that follows the call of [35, p. 685] to combine the competence perspective with the breadth and depth the O*NET database offers, which is without doubt the most widely recognized and up-to-date job database internationally.

In this regard, the research question is: *How can we establish a model of competences by integrating the relevant descriptors from the O*Net?*

To address this research question and thus the gap in research, we develop a conceptual model in which we depart by taking four broad competences as given (personal competence, social competence, methodical competence, domain competence) [17]. Looking through these glasses, we integrate the descriptors of the O*Net into the framework of competences.

This paper contributes both, to theory and practice. Theoretically, we add a model to the existing literature that combines the O*Net with a competence perspective and in doing so we hope to "promote good practice around competencies [...] and make their use more efficient" [8, p. 260]. To the best of our knowledge, we are not aware of any attempt to reconcile the "competence-camp" with the "O*Net camp". As the model integrates the relevant descriptors from the O*Net, it allows to directly translate defined competences into measurable construct parameters. We aim to show that these

perspectives are not mutually exclusive but rather complement each other in a meaningful way, which can be seen in existing best practices [8].

The remainder of the paper is structured as follows. In section 2, we provide the theoretical background to answer the research question. Here, we introduce the O*Net and the EQF. In section 3, we show the development process of the model and introduce and explain the model itself. Finally, in section 4, we discuss the findings and present limitations of the competence framework. Here, we also discuss opportunities for further research.

2. Theoretical background

This is a conceptual work within a larger case study in which we outline the methodic process of developing a framework to classify the O*Net within larger competence categories. In doing so, we employ theory building and offer an incremental theoretical contribution which should be practically useful [10].

Competences are defined as "collections of knowledge, skills, abilities, and other characteristics (KSAOs) that are needed for effective performance in the jobs in question" [8, p. 226]. In this regard, knowledge refers to the "possession of a body of information (both factual and procedural) that is related to the performance of a task" [24, p. 463]. Skills are defined as "a person's level of proficiency [...] to perform a task. Skills usually improve with training or experience on the task." [24, p. 464]. Abilities are relatively "enduring basic capacities for performing a wide range of different tasks" [24, p. 458].

As outlined above, there is no agreed definition on competence, that is why we decided to follow the argument that competence may be used based on a constructivist approach of viability [28]. In this regard, we follow the definition of the European Union, in which 'competence' means the "proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development" [12].

2.1. The Occupational Information Network (O*NET)

The Occupational Information Network [24] is a large job analysis database operated and maintained by the U.S. Department of Labor. It resulted in 1999 from the dictionary of occupational titles in which finally over 12000 occupations were listed. As this large number of entries could not be handled anymore, psychologists began to develop the O*NET and

drastically reduced the number of jobs by extracting the relevant psychological parameters that are relevant to pursue most of the jobs. In this regard, the O*Net stands in the tradition of taylorism and fordism. Nowadays, O*NET is organized as a comprehensive database of worker and occupational characteristics that is continually updated through surveying a broad range of workers and job analysts. The database, available to the public free of cost, contains descriptions of the knowledge, skills, abilities, interests, and general work activities associated with each of around 1,000 different US occupations [7,11].

The key organizing framework of O*NET is a taxonomy of occupational descriptors known as the O*NET content model [22]. The main motivation for the development of the O*NET model has been to address three needs: the ability to describe occupations in many ways, a common language of work descriptors that can be applied across all occupations, and a taxonomic classification system [24].

The model contains almost 250 measures of knowledge, skills, abilities, work activities, training, work context and job characteristics, which are either worker-oriented or job-oriented. For the four domains of knowledge, skills, abilities and work activities, both the 'importance' and 'level' of each skill or characteristic being measured is recorded [11]. A detailed description of the O*NET and all the data can be found at the website of this project https://www.onetonline.org/.

2.2. The European Qualification Framework EQF

Hunnius and Schuppan point out that because of the increasing importance of lifelong learning, the competence approach is enjoying larger recognition worldwide, as it focuses on the results of learning processes [16]. In Europe in particular, the competence concept has become important in establishing comparability between educational degrees issued in different countries. When applied in professional life, the competence concept takes into account what a person is able to do in a working context, regardless of how this knowledge has been acquired. Instead of formal qualifications and degrees, which differ throughout Europe, skills, techniques, expertise, and know-how become more important.

Addressing this claim the European Qualification Network (EQF) has been developed in the last decade. The EQF is described as a 'meta-framework' or 'translation device' which allows for the comparison of one or more qualifications from one or more countries [20]. A central principle of the EQF is that

its levels are based on learning outcomes rather than either the type of a program that leads to the qualification, or the institution in which it is taken.

Three main reasons have been given for the creation of the EQF: international transparency (among all the members and looking outwards); the possibility of international recognition of professional qualifications obtained in different countries; and student mobility. The aim has been to create a meta-framework that encompasses and connects the national frameworks, to make them compatible. These frameworks should be based on a common concept of professional qualifications. The meta-framework should include a systematic description of qualification levels, with coherent relations and conditions for it to be understood internationally [14].

The EQF is organized into eight levels, from primary education to doctoral level equivalents and for any qualification, a level of achievement is assigned. Each level consists of three components of, respectively, knowledge, skill and competence, the latter being concerned with the qualification holder's exercise of autonomy and responsibility in work situations [6].

3. Method

3.1. Overview of the development process

Methodically, we constructed the net of competences within a qualitative research paradigm. In this case we understand "engaging in creative attempts to generalize mechanisms, particular cases, or links between causal statements" [29, p. 167] by constructing theory.

The net of competence is a model that literally *bridges* the four broad competence dimensions (personal competence, social competence, method competence and domain competence) from the (mainly european) discourse with the O*Net taxonomy. In this section, we describe how we build the "semantic bridge" between broad competence dimensions and the very detailed descriptions within the O*Net. In this sense, when linking competences and descriptors of the O*Net, we relied on abductive reasoning [23] as it supports the generation of new hypotheses and concepts (i.e. the bridge). Comparing to deductive thinking, abductive thinking is less certain but comes with a greater innovative potential. As such, abduction is used as a method in disciplines such as product design or product innovation. The process of model development was mainly done by the first author (as indicated in subsequent sections) and was validated by the co-authors in a community of

inquiry in the end of the process [29, p. 180].

In general, we aimed at integrating the O*Net descriptors into the competence framework. More specifically, we used the database O*Net *Content Model Reference*, which includes all descriptors that structure the O*Net database. The respective excel sheet (Content Model Reference) is accessible at https://www.onetcenter.org/db_releases.html and includes 548 occupational descriptors which served as primary data for model development (see Figure 1 for an overview of the process).
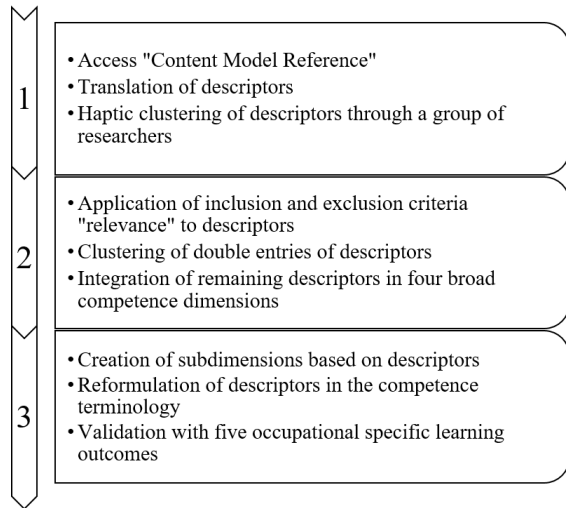

Figure 1. Development and validation of the model of competences (1: data preparation; 2: data analysis; 3: data refinement and validation)

3.2. Detailed description of the development

In this section, we report in detail how the net of competences was developed. The development process can be divided into three steps, namely data preparation, data analysis and data refinement & validation, with three substeps each that are outlined below.

3.2.1. Data preparation. The data preparation phase (Figure 1: 1) started on 05.05.2018. The data preparation phase was done by the first author (FF).

First, FF downloaded the datafile "Content Model Reference". The file consists of three columns: *Element ID* provides an unmistakable identification for the content element, *Element Name* provides a brief name for the corresponding content element and *Description* provides a brief description and definition of the respective content element. The overall content model is theoretically described in [24] (Figure 2 gives an example of the structure).

Figure 2. Example descriptors of the O*Net Content Model Reference

Second, as this model is intended to be applied in the german speaking region, FF translated the whole "Content Model Reference" into german. New columns were added into the datafile in order to keep the reference to the original data.

Third, FF printed each of the translated rows of the 548 descriptors on a small label (10x5 cm) and placed them on the ground of a meeting room. The Element ID ensured that the reference of the translated data to the orginial data is always given. When placing the labels in the seminar room, the clusters mirrored the O*Net structure and hierarchy (see Figure 3 for an example).
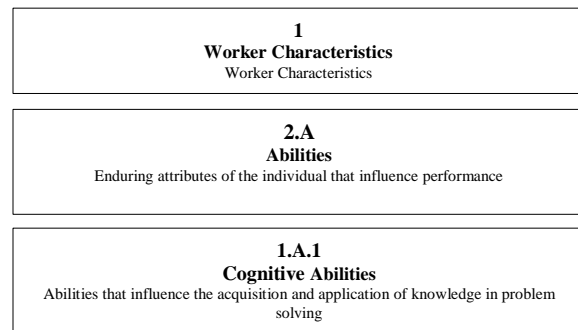

Figure 3. Examples of the hierarchically clustered descriptors of the O*Net Content Model Reference (Clustering was done with translated data)

3.2.2. Data preparation. In the data analysis phase (Figure 1: 2), an algorithmic procedure to clean the data and regroup it semantically, was applied.

First, the inclusion and exclusion criteria *relevance* was applied. More specifically, FF manually went through all descriptors of the O*Net and decided whether the respective descriptor is relevant to develop a model of competences or not. A descriptor was considered relevant if it describes a measurable human variable or job variable. Descriptors were excluded that did not elicit information regarding measurability of a construct or the possibility to connect the respective dimension with one of the competences. For example, information regarding the (future) outlook of an occupation, or information about certifications necessary to perform a certain

occupation was excluded. In this regard, information, relevant to build a conceptual model was separated from information that is solely necessary to organize the O*Net taxonomy but does not contribute semantically.

Second, semantically double entries were merged if they did not provide additional information. Within the O*Net, certain descriptors are formulated semantically similar as *worker requirements* and *entry requirements* for a certain occupation. Clusters were merged when they contained semantically similar information. For example, the category *Basic Skills* occurs twice in the data set with the as worker requirement and entry requirement. In such a case the information was merged into one category.

Third, FF semantically sorted the remaining descriptors and merged them into the four broad competence dimensions. At this point, the net of competences consisted of four broad competence dimensions and very detailed descriptions from the O*Net. However, the bridging subdimensions and their definition was still missing at this point.

3.2.3. Data refinement and validation. In the data refinement and validation phase (see Figure 1: 3), all authors worked together. In this phase, we constructed the bridging terms and reformulated the O*Net descriptors in a competence terminology. We subsequently validated the model using qualification standards from five different occupations (see section 4.3).

First, we generated the 32 bridging terms between the competence framework and the O*Net dimensions in several iterations. These bridging terms can be seen as a result in section 4 for each competence dimension.

Second, we reformulated the bridging terms and the O*Net descriptors into a competence terminology, taking into account what a person is "able to do".

Third, we validated our model for semantic breadth and depth using qualification standards from five different occupations performed in Austria. Qualification standards are documents that specify learning outcomes including knowledge skills and competences. In this step we aimed to match every learning outcome into the Net of competence and the respective subdimension of the O*Net. Data validation showed that the net of competence is able to account for the qualification standards of five different occupations in Austria (see section 4.3). Afterwards, the bridging terms and their description were cross-checked with labour market experts from the Austrian Chamber of Commerce.

As this model is intended to be used by all labour market participants (also non-native speakers) in german speaking regions, we made sure to use a wording for the subdimensions which is easy to understand.

4. The resulting net of competences

The resulting net of competences is comprised by four different dimensions (see Figure 4) and 32 subdimensions, which are described in the following. We use the phrase *The person is able to...* to underline the competence perspective. This is because the phrase *The person is able to* is used to describe the learning outcomes within the EQF. Within the EQF learning outcomes are depicted strongly oriented towards individual competence. The following section provides the bridging terms between the competence framework and the O*Net descriptors.
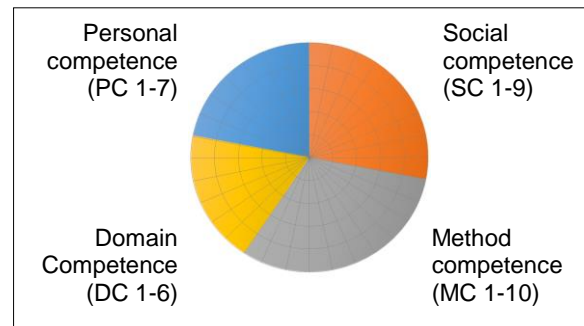

Figure 4. The net of competences consists of four different dimensions

4.2.1. Personal competence. Personal competence describes the "willingness and ability, as an individual personality, to understand, analyse and judge the development chances, requirements and limitations in the family, job and public life, to develop one's own skills as well as to decide on and develop life plans. It includes personal characteristics like independence, critical abilities, self-confidence, reliability, responsibility and awareness of duty, as well as professional and ethical values." [17, p. 38]. Within the field of personal competence, we defined seven subdimensions derived from the data in the O*Net content reference (see Table 1).

Table 1. Subdimensions of personal competence

ID	Name	Description
PC1	Socialisation through education or culture	The person is able to use his/her education and cultural background to perform appropriate at his/her workplace

PC2	Suitability based on personality characteristics	The person is able to perform at his/her workplace based on his/her personality characteristics
PC3	Suitability based on interests	The person is able to reflect on his/her professional interests and match these to the demands at the workplace
PC4	Achievement motivation	The person is able to reflect on his/her key strengths and use them at the workplace
PC5	Management of values	The person is able to reflect on his/her values and on organizational values
PC6	Setting and pursuing goals	The person is able to set goals and pursue them at the workplace
PC7	Act practically intelligent	The person is able to use his/her common sense at the workplace

We are aware that PC3, PC4, PC5 are described using the term *reflection*. We do so in accordance with [9] who state that reflection [26] is a meta-competence and plays an important role in the enactment of competences in general.

4.2.2. Social competence. Social competence describes the "willingness and ability to experience and shape relationships, to identify and understand benefits and tensions, and to interact with others in a rational and conscientious way, including the development of social responsibility and solidarity" [17, p. 38]. Within the field of personal competence, we defined nine subdimensions derived from the data in the O*Net content reference (see Table 2).

Table 2. Subdimensions of social competence

ID	Name	Description
SC1	Sense of social appropriateness	The person is able to act in a social appropriate way at the workplace
SC2	Communication and interaction	The person is able to communicate and interact with others in a goal oriented and appropriate way at the workplace
SC3	Active and passive feedback	The person is able to give feedback to others and receive feedback from others at the workplace

SC4	Empathy	The person is able to act in a friendly, cooperative and empathic way with others at the workplace.
SC5	Ability to form and maintain relationships	The person is able to support others and to build strong relationships with others at the workplace
SC6	Occupational roles	The person is able to negotiate about the own role in the occupation at the workplace
SC7	Leadership and social influence	The person is able to exert influence in social systems and to lead others at the workplace
SC8	Conflict management	The person is able to solve conflicts constructively at the workplace
SC9	Advice and development	The person is able to advice others and be responsible for their professional development at the workplace

4.2.3. Method competence. Method competence arises "from the implementation of transversal strategies and processes of invention and problem-solving" [17, p. 36]. Here, transversal strategies are cross-functional and span a variety of occupations. Within the field of method competence, we defined ten subdimensions derived from the data in the O*Net content reference (see Table 3).

Table 3. Subdimensions of methodical competence

ID	Name	Description
MC1	Socio technical systems	The person is able to understand, monitor and improve socio-technical systems at the workplace
MC2	Resource management	The person is able to manage his/her and organizational time and finances
MC3	Human resources systems and practices	The person is able to ensure that an organization has fitting employees to meet their organizational goals

MC4	Solving complex problems	The person is able to solve new, ill-defined and complex problems in the real world
MC5	Performing complex technical activites	The person is able to perform skilled activities using coordinated movements
MC6	Operate and use machines and technical systems	The person is able to use his/her developed capacities to design, set-up, operate and correct malfunctions in machines and technical systems
MC7	Digital communication	The person is able to appropriately use different methods and ways of digital communication
MC8	Manage knowledge and information	The person is able to identify and manage knowledge and information at the workplace
MC9	Business management	The person is able to apply knowledge of principles and facts related to business management at the workplace
MC10	Administrative work	Persons are able to perform routine operations like administration, staffing or controlling at the workplace

4.2.4. Domain competence. Domain competence describes the "willingness and ability, on the basis of subject-specific knowledge and skills, to carry out tasks and solve problems and to judge the results in a way that is goal-oriented, appropriate, methodological and independent. General cognitive competence [...] the ability to think and act in an insightful and problem-solving way" [17, p. 38]. Within the field of personal competence, we defined six subdimensions derived from the data in the O*Net content reference (see Table 4).

Table 4. Subdimensions of domain competence

ID	Name	Description
DC1	Domain Knowledge	The person is able to use domain specific knowledge to perform at the workplace
DC2	Work settings	The person is able to work in different physical environments
DC3	Environmental conditions	The person is able to withstand extreme environmental conditions at the workplace
DC4	Handling of dangerous conditions	The person is able to handle different dangerous or hazardous conditions at the workplace
DC5	Physical and cognitive requirements	The person is able to handle the physical and cognitive requirements at the workplace
DC6	Work conditions	The person is able to work under different and changing conditions

4.3. Validation of the net of competences

The conceptual development of the net of competences was part of a larger ongoing project we conduct with the Austrian Federal Economic Chamber (WKO). The project's objective is to develop a model for the industry sector 'Crafts and Trades' which helps to decide whether a person has the developed competences to lead a company within a specific occupation. Such a trading licence is given to a person only if his or her competences ensure an outcome of high quality. Therefore, the competences of a person have to match with the requirements of a specific occupation. Within Austria, there exist almost 180 different occupations with very different demands. In this regard, the aim of our project is to develop a competence based model which can be applied to all non-academic occupations. A large part of the project is thus to maintain the qualitative high performance of persons obtaining trading licenses.

In the meta-framework of the EQF, it is necessary that each participating country develops a national quality framework (NQF), which fits to the EQF. In the Austrian context, the NQF requires representatives of the respective occupation to formulate learning outcomes for the highest non-academic qualification (Meister).

In the project, we obtained data from five different occupations with around 50 learning outcomes each. For example the term *"He/she is able to set goals for the organization and pursue them"* is an exemplary learning outcome from the occupation of plumbers.

Within the validation phase, we investigated in a group of scientists, whether each of these learning outcomes from the five occupations can be associated to at least one of the 32 subdimension in the net of competences described above. To describe the process of matching in detail, is out of scope for this paper. However, during the validation, we came to the conclusion, that not only each learning outcome could be associated with at least one subdimension in the net of competences, rather we also concluded that roughly 66% of the learning outcomes from very different disciplines semantically overlap.

5. Discussion and conclusion

In this paper we outlined a net of competences. It has to be mentioned, that the net of competences is not *finished* yet, rather it comprises a first iteration in an ongoing development. Like within the O*Net or software development projects, a version control may be applied to further iterations.

Acknowledging the importance of lifelong learning leads to continuous change [32] in the competences and KSAOs a person possesses and is able to perform. In this regard, nonformal education [3,4] and lifelong learning [19] create a breadth and depth of "nonprototypical cases" instead of "prototypical cases" in the institutionalized system of education [30]. In order to maintain and foster quality within the admission of trading licenses of individuals, it is important to use the full inventory of tools which have been developed in industrial and organizational psychology within the last decades to break down competences into psychological relevant constructs and methods [25].

5.1. Implications for theory and practice

In this regard, this paper contributes both, to theory and practice. Theoretically, we add a model to the existing literature that departs from a competence perspective and subsumes the relevant descriptors of the O*Net into this perspective.

In doing so, we aim at reconciling the more restrictive and normative European competence perspective which focuses on quality within professional education with the more liberal and descriptive "O*Net". As the model integrates the relevant descriptors from the O*Net, it allows to directly translate defined competences into measurable constructs. We show that these perspectives are not mutually exclusive but rather complement each other in a meaningful way.

Practically, we contribute a model at an early stage, which should, in its maturity allow to integrate several different occupations in the occupational landscape in the german speaking regions. We used a competence perspective to translate learning outcomes from the national qualification framework (NQF) into assessible parameters and constructs. In so doing, we acknowledge that the net of competences has a potential wider range of application, such as a self-assessment of individuals on their level of competence. It may well be possible to recognize "learning outcomes, irrespective of the routes of acquisition involved [...] but have nonetheless developed competence experientially" [17, p. 28]. In this regard, we also translate the EQF and Austrian NQF, which employ a perspective on the whole vocational system to a perspective of the individual. In doing so, we aim to construct a model that assesses educational equivalence instead of educational uniformity by linking the net of competences to levels of experience [1,5].

5.2. Limitations and further research

At this time, we only validated the learning outcomes of five different occupations. Although these five occupations are very heterogeneous, we currently do not have insights whether all the other Austrian occupations can be integrated into the net of competences. Therefore, the validation process has to be continued and enlarged. Further research should also validate the applicability of the model for learning outcomes described in other national quality frameworks. Another limitation is the lack of a concrete and implemented algorithm for assessing and measuring the 32 subdimensions of our net of competences.

Based on the promising results from the different occupations so far and the limitations mentioned above, our further work will focus on developing and implementing measurements of different levels with the stages of competence development [1,5]. Furthermore, further research should take into account that lifelong learning is also strongly connected with nonformal education [3,4]. Therefore, future versions of the net of competences have to provide opportunities for uploading complete biographies to the system. Hence, individuals have to be supported to think about their competences in a holistic way. One way to realize this could be the integration of systemic

coaching techniques for creating an enabling space as well as employing narrative knowledge management facilitate the reflection on biographies.

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