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ENHANCING THE QUALITY OF ADVANCED VOCATIONAL QUALIFICATION BY COMPUTER-ASSISTED GENERATION OF INDIVIDUAL TRAINING CONCEPTS

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ABSTRACT
Life Long Learning and continuous vocational training nowadays are necessities to sustainably maintain the capacity of employees. The effectiveness of any measure of qualification depends on a proper fitting of the competences imparted therein with the required competences for the execution of the employee's tasks and his preknowledge. Thus, the adequate election of training offers is indispensable for a successful qualification. Yet, it is often difficult to choose a training offer fitting optimally. Therefore, a concept was developed for an assistance tool for the definition of a customised training concept meeting the individual needs and constraints of the learner.

Keywords: Assistance system, advanced vocational training, customisation

1. INTRODUCTION
The quality of products or services provided by an enterprise and thus finally the economical success of the organisation depends strongly on the capability and willingness of the employees to perform their tasks correctly and efficiently. Conventionally, it is assumed that employees gather the competences required for the execution of their tasks mainly from primary and secondary education in school and a following specific vocational training for the intended profession, provided either by university studies or hands-on-practice in industrial enterprises depending on the professional target qualification. During vocational life, it is desired that this basic qualification is amended by broadening experiences in the chosen field of work, resulting in a deepened understanding and a honing of necessary skills towards higher efficiency and finally mastery or expertise of the specific area.
Yet, nowadays this concept of improvement by growing experiences based upon a once given fundamental qualification is not any more applicable for most areas of work. Rather, especially in areas related to engineering or technology, there is such rapid a development of methods and tools that knowledge once gathered during basic vocational training maybe obsolete after only a few years. Also, there is a need for all employees to gather additional competences in order to apply newly developed technologies correctly in their tasks. Resulting from this situation, the focus of imparting required vocational competences has to be broadened from a concentration on basic training towards the concept of Life Long Learning and measures of continuous qualification throughout the whole professional life of employees, in order to sustainably enable a high quality of their work.

This need becomes evident strongly regarding the special area of manufacturing metrology with its vital role for assuring the conformity of manufactured products with given specifications of geometrical shape. Due to increasing demands on accuracy of measurement results together with narrowing constraints of acceptable inspection time, manufacturing metrology constitutes a rapidly developing field of technology. Therefore, employees regularly have to accomplish the application of new technologies in measurement devices. The provision of adequate arrangements of continuous qualification here is of special importance as many employees working in this area do not even have a sufficient basic education as metrologist to build upon for self-conducted learning in a conventional way, given the fact that in most countries there is no special training for metrologists.

In order to enable an efficient and sustainable impartment of competences, the provided measures of qualification themselves also have to be of high quality, i.e. to fulfil the requirements of customers on the qualification. To express the quality of an educational activity, on the one hand the impact on competences of the participants has to be regarded. They shall on short term be able to apply their newly gathered skills efficiently to their actual tasks, on long term maintain and deepen their knowledge and thus sustainably improve the quality of their work. On the other hand, the satisfaction of learners has to be considered which depends not only on the outcome but also on the proceeding of a course regarding contents, implemented methods of teaching and learning and general circumstances.

Comparing different employees or different fields of application in manufacturing metrology, the intended profile of competences as well as the existing basic knowledge varies strongly. Thus, also the required content and method of any measure of qualification depends strongly on individual constraints. To provide training of high quality for manufacturing metrology, it is therefore necessary to enhance a proper fit with individual requirements.

Although a large variety of training offers is provided by the manufacturers of measuring machines, universities or other institutions [e. g. 1, 2], the specific demand of a learner will rarely be met by a ready-made training concept. In order to fulfil an individual demand, it is possible either to create a personalised training or, to combine ready-made training offers in a modularized way to form an individual training concept best fitting the actual demand. With individually designed courses, the comparability of gathered competences is reduced considerably and also the arising costs usually are quite high. Yet regarding the election of standardized training offers, it is very difficult for the learner to identify adequate courses in order to define an optimal training concept.

Thus, to support the learner with the election of appropriate training offers and enable the definition of an individual training concept, an adequate facility for assistance is required.

2. CONCEPTUALISATION OF AN ASSISTANCE TOOL FOR SCHEDULING OF QUALIFICATION

Regarding advanced vocational qualification, the never ending demand for continuous improvement usually is envisioned as a staff development cycle rather than as a unique event. To describe the phases of this development cycle, different models are used [e. g. 3, 4]. Yet, they can be summarised in a seven stepped model (figure 1):

1. Analysis of required competences
2. Assessment of available competences
3. Identification of demand for qualification
4. Election of adept training offers
5. Participation in training
6. Utilization of gained knowledge in professional tasks
7. Assessment of training success

Based on the results of the assessment as well as driven by new requirements, the cycle will start all over again. Regarding these phases, there is usually a strict focus on the actual participation in training, by providers of qualification regarding development and quality assurance processes as well as by the customers regarding internal controlling and assessment of training offer. Yet, the success of a measure of qualification, which finally determines its quality perceived by the participant as customer, does not only depend on the training itself, but also on the preceding phases of planning and election of the training offer as well as on the subsequent transfer of newly gained knowledge and skills to the performance of actual tasks. Therefore, an appropriate assistance tool for the scheduling of qualification has to support the whole cycle of staff development.

As a basis for the further development, requirements for the tool have to be specified, regarding both functionalities and overall properties. Regarding properties, especially user friendliness has to be considered. The system has to be easy to handle, robust against possible user mistakes and self-explaining. The imparted information has to aim for completeness regarding trainings on the market and for correct descriptions. Also, preferably the tool shall be accessible by all interested employees in metrology in order to enable target-oriented advanced training. For this, independence of other systems and low requirements on a user's computer are desirable. In order to define the intended functionalities of the tool, based on the seven stepped model for each phase it has to be analyzed, in which way a person trying to find suitable measures of qualification could be supported. This concept of functionalities can be summarized in a workflow diagram (figure 1).

During the first two steps, analyses of competences have to be executed, regarding on the one hand the competences required to fulfil the given tasks correctly and efficiently, on the other hand measuring the current competence profile of a specific person intended to perform this task. Here, it is necessary to provide a possibility for the comparable description of the intended or available competences. This has to include a comprehensive portfolio of relevant skills as well as an adequate set of categories for rating desired and current state against it. For both steps, the same scheme for assessment has to be used in order to provide comparability between the two recorded profiles. This information also can be used as subject-specific input for describing job characteristics respectively for performance appraisal of employees or as a tool to support accreditation of competences gathered via informal learning processes or former, non-standardised measures of training.

For the following identification of demand for qualification, targeted and actual competence profile have to be compared and occurring deficits have to be highlighted. Also, a recommendation is useful if additional training is necessary or if identified deficits are likely to be easily smoothed out by increasing experience in the execution of tasks or by exchange of knowledge among co-workers.

In order to schedule measures of qualification adequate for the specific situation of the intended learner, besides the content of training specified by the identified deviations of competence profiles also other constraints have to be considered. Thus, requirements regarding disposable time, acceptable costs, formal specifications such as level of education and previous training with accredited certificates, available technical infrastructure, preferred method of learning and other constraints, e.g. maximum travel time for seminars, have to be collected. Based on this comprehensive analysis of user requirements, possible training schedules can be first generated to cover the identified gaps in competences and then assessed regarding the fulfilment of the additional requirements. As a prerequisite for this recommendation, a data base of generally available training offers is required, where contents and circumstances are described. The results are displayed to the user, who selects one of the suggestions. If no suitable offers are to be found, the collected data may be used as specifications for an individually developed training.

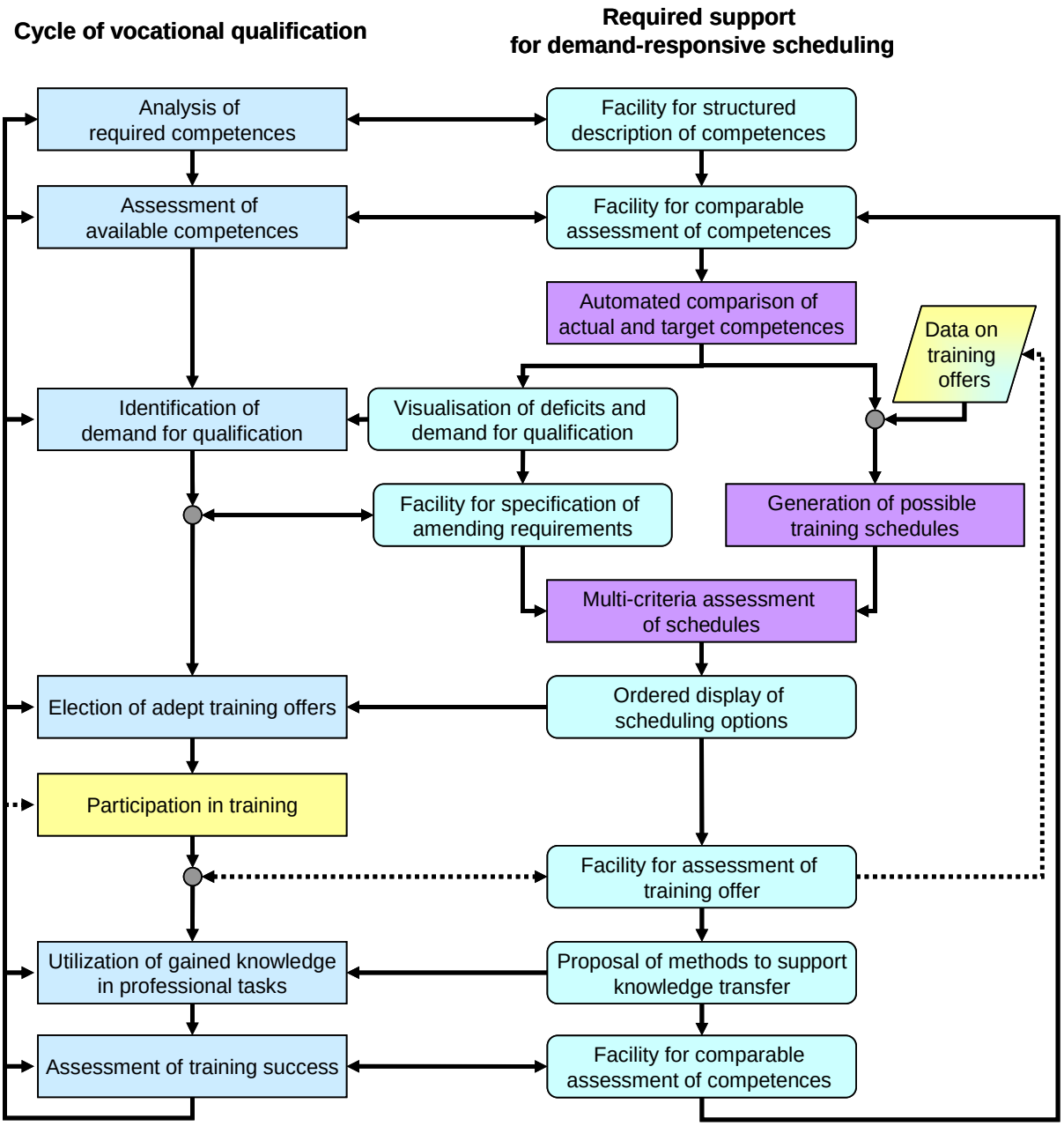

Figure 1. Required functionalities of an assistance tool for holistic support during qualification cycle.

For the actual participation in the qualification program, no support from the tool is required. Yet, afterwards a possibility for assessing the training should be offered. The gathered results can be included in the data base and thus enable a fine-tuning of recommendations.

Also, suitable methods to support the transfer of newly gained competences to the performance of actual tasks and enhance activities of knowledge sharing with co-workers should be proposed to increase the effect of training for the actual participant as well as for the whole department [5].

Finally, after a certain time to assure an unbiased assessment, the now available competences should be measured and compared with the target profile. Here again a standardized set of categories and observed skills is needed, where the same criteria are used as during the first assessment of competences and the definition of target competences. Based on these results, the cycle eventually can be started all over again.

3. DESIGN OF ESSENTIAL FEATURES FOR THE ASSISTANCE TOOL

For the realization of the assistance tool, three essential features have to be developed: A method for competence analysis in manufacturing metrology, a strategy for the generation of possible training schedules and a multi-criteria analysis of the generated schedules.

A comprehensive *competence analysis* for manufacturing metrology has to consider in one dimension all relevant topics and in another dimension the various kinds of required competences, depending on the tasks to be performed. Regarding topical categories, the field of manufacturing metrology can be structured in typical sub domains widely used for classifying the various inspection devices, e.g. gauges, coordinate metrology, form measurement etc. [6]. Additionally, basics of metrology have to be considered, such as interpretation of geometrical specification, terms and definitions or determination and interpretation of measurement uncertainty. For each topic, different modes of competences have to be assessed. In context of advanced vocational training, the focus is set on cognitive ("know that") and functional ("know how") competences as subdivisions of topical professional competences [7]. Other modes of competences, social and personal, may be neglected in this specific purpose, as their development – which is necessary for a high overall performance of the employee – cannot be effectively provided via topical training but needs to be included in a more generalised learning culture in the company. For each topic, cognitive and functional competence is rated on an ordinal scale with five categories. Each category is described by the according typical level of performance to enable a transparent and reproducible assessment. The defined analytical items are also used to describe the learning aims of a specific course in the data base.

For the *generation of training schedules* two strategies are combined. Using "backward-strategy", the target profile of competences is considered as starting point. Training offers that enable the achievement of the intended competences are selected from the data base. Their prerequisites regarding previous knowledge or formal qualification are compared with the actual profile. If the requirements are not fulfilled, the requested profile is considered as new target. The step is iterated until a schedule of successive courses is defined, connecting target and current profile. Using "forward-strategy", the current profile is considered as starting point and possibilities to progress from here are checked. The possibility which provides the best reduction of gaps to the target profile is elected. If there is a remaining demand, the step is iterated. Generally, the backward-strategy is more likely to provide an effective training schedule, if there is a training offer imparting the required competences. Yet, the forward-strategy enables a preliminary break, e.g. if only a limited amount of costs are tolerated.

For the *assessment of generated training concepts* against the specified requirements, for each criterion (topical fit, costs, learning methodology and organisational constraints) a degree of fulfilment is calculated, expressed by a value between 0 and 100%. The relevant information for each course is also contained in the data base. The values of all criteria are combined by multiplication in order to avoid high ranking of schedules with severe drawbacks in one category. When displaying the rated training schedules, the ranking in each category is visible for the user. Thus, finally an informed decision can be taken for a specific training concept.

4. EVALUATION OF IMPLEMENTATION STRATEGIES

Regarding the implementation of the actual assistance tool, there are two main possibilities: A realization as a closed system or as an open system. For a closed system, there would be a fixed set of possible users and also a limited choice of included training offers only to be changed or amended by especially authorized persons, bringing along the necessity of a

regular update of the database in order to provide up-to-date information. But it would also be possible to include offers that are not commonly available, e. g. own specific programs of an industrial enterprise. Thus, an implementation as a closed system would be highly useful for the support of staff development in large companies. This can be realized by a classical software application with regular updates for each user or rather by a client-server application, which can be centrally updated. The latter would also enable a combination with existing similar systems in the company, e.g. for CAQ.
For an open system, the group of possible users is not limited. Rather, a facility to assess one's competences regarding manufacturing metrology and schedule an appropriate training should be provided for all interested users. This would demand the implementation of a web-based platform. Including typical facilities of Web 2.0, the possibility to realize a community of practice should be used for the exchange of expert knowledge. Experiences with a training offer could be taken into account by other users. Also, the need for a complete capturing of qualification offers included in the database could be met more easily, as providers could apply for an inclusion themselves rather than having to be found, even if the input in the data base generally should be performed by qualified staff to assure comparability. Thus, the important aspects of social connectivity required for successful learning can be facilitated.

5. CONCLUSION AND OUTLOOK

By a holistic assistance tool for the scheduling of advanced vocational training, an individually adapted generation of training concepts for manufacturing metrology is facilitated. Thus, measures of qualification can be efficiently oriented towards the specific demand of learner and company and high quality of advanced vocational training can be assured. So far, a functional concept and essential algorithms for the assistance tool have been described. The feasibility of the concept has been checked and basic possibilities for the implementation have been analyzed. Currently, a prototype of an open system is developed including a facility for the assessment of competences in manufacturing metrology and an initial data base of training offers. Thus, the general acceptance of the tool by the intended user group can be evaluated.
Based on these experiences, the concept can be easily adapted also to other areas of interest, as specification on a special topic is provided only via the training offers contained in data base together with the assessment of relevant competences. Thus, the developed concept may provide a general base for quality assurance in human resource development.

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