5th Research/Expert Conference with International Participations
"QUALITY 2007", Neum, B&H, June 06-09, 2007.

BLENDED-LEARNING COURSE MESS-IN – ADVANCED VOCATIONAL TRAINING IN INDUSTRIAL METROLOGY

Albert Weckenmann
Teresa Werner
Chair Quality Management and Manufacturing Metrology
University Erlangen-Nuremberg
Erlangen
Germany

ABSTRACT

For the correct performing of measurement tasks, the operator needs a lot of knowledge. As so far in Germany there is no adequate education in metrology, in the project Mess-iN a concept for advanced vocational training was developed. The course consists of two phases: A learning phase focusing on the gathering of knowledge via a combination of web-based learning modules and workshops and a project phase focusing on the transfer of knowledge into daily practice. By the integration of learning into working, the course Mess-iN offers an efficient education and enhances the long term success of the training.

Keywords: Metrology, Blended Learning, Advanced Training

1. INITIAL SITUATION

Reliable and reproducible measurement results are an essential basis for the establishing of an efficient quality management and thus for the manufacturing of high quality products. To achieve these, the operator needs on one hand extensive skills in the handling of his measuring machines and devices, on the other hand profound metrological knowledge to choose an apt measuring device, to set up a proper measuring and evaluation strategy and generally to avoid mistakes and thereby reduce influences on the measurement.

Whereas a lot of courses regarding the handling and programming of the machines are provided by the various manufacturers, there are rarely any training offers aiming at the imparting of fundamental knowledge for manufacturing metrology. Thus, the operators have to gather the needed information mainly by themselves, as so far there is no basic vocational education for metrologists in Germany. Of course this does not always lead to a satisfactory understanding of complicated subjects. Therefore quite often problems occur, mainly regarding the correct planning of the measurement in reference to product specifications given by drawings and the interpretation of acquired results. These may lead to different measurement results between customer and supplier.

Via the course 'Mess-iN' (Metrology – Learning in a network), there shall be provided a comprehensive concept for advanced vocational training in manufacturing metrology, focused on the needs of operators in industrial measuring regarding both contents and design of methodology. Thereby also the framework for the future development of a standardized, commonly accepted vocational training in manufacturing metrology shall be laid.

2. CONCEPT OF THE COURSE MESS-IN

Each training offer for advanced vocational training first of all has to meet requirements of the intended target group regarding content and didactical methodology, but also has to consider economical aspects.
Regarding content and didactics, the training has to impart relevant knowledge in such a way, that the participants are able to transfer it into their daily work and use it to solve their particular problems. To meet the different background of participants, the concept has to provide a high degree of freedom, regarding adjustability to different preknowledge, experiences and interests. Yet, the provided education shall establish comprehensive understanding and skills for the reproducible execution of a maximal variety of tasks in manufacturing metrology.
Regarding economical aspects, the participation in the course should not cause high costs for participant or employer. This is of special importance for a basic training, because positive effects of a profound understanding are less visible on short term, but the benefits are gained mainly on long term. Therefore basic training is often regarded as a pure factor of cost by the employers. Yet, the operators mainly are well aware of the problems caused by lack of knowledge and thus are strongly interested in gathering the required skills via further vocational training, even willing to invest spare time. Therefore, the course has to enable the combination of learning with work and other commitments of the participants.
As the fulfillment of these requirements mainly depends on the implemented concept of the training, pedagogical forms and methods thoroughly have to be analyzed for the definition of an adequate methodology.

2.1. Definition of methodology

The participants of the training shall gather knowledge about metrological principles, methods and standards and shall also be able to use these skills competently in their daily work. Therefore imparting of theoretical information has to be supported as well as using the lessons in practical problems, in order to enable the efficient transfer of gathered information to the performing of actual measuring tasks.
Conventional attendance-based education provides nearly unlimited possibilities to design learning contents, but only in a strictly limited margin it is possible to react to the needs of a single person. Also, high costs may incur - regarding travelling, accommodation and the need for a stand-in to fulfil the participants' daily duties. Open distance learning offers, on the other hand, provide a high degree of freedom and therefore can be combined with other duties, but do not yet provide sufficient possibilities of practical training.
Therefore both methodologies are not apt for an exclusive use in an advanced vocational training for metrology. To combine the specific advantages of both attendance based training and open distance learning, the course Mess-iN is implementing a Blended Learning concept. The contents are imparted via a combination of web based learning modules and workshops, which take place in regular intervals. As a special focus has to be set on the transferability of knowledge to daily work, the course consists of two phases: The self conducted gathering of knowledge, supported by a tutor (learning phase) and the transfer of gathered knowledge into the daily routine by working on a project, which requires the use of newly gathered skills to solve a metrological task (project phase).
Finally in an examination the skills of the participants are tested. To receive the certificate, it is necessary to be successful both in the examination of theoretical knowledge and in working on the project.

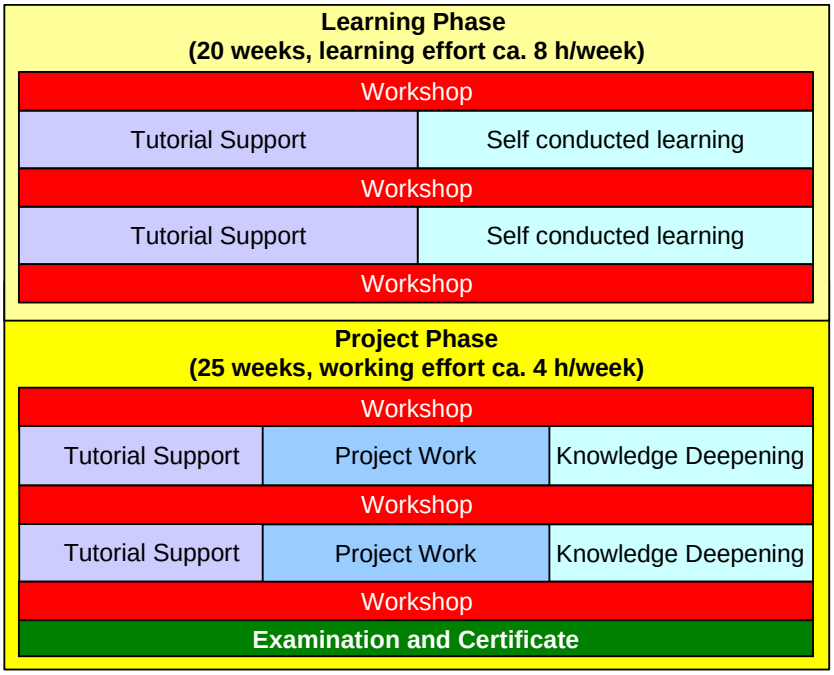

Figure 1. Concept of the course Mess-iN

By a User Needs Analysis it was checked, whether there is interest for this kind of training concept among the intended target group of measuring operators and if the necessary conditions for a successful participation are given. The analysis showed, that the concept of Blended Learning was of great interest for the target group. The necessary infrastructure for the use of web based contents – a computer connected to the internet – is available. Also the acceptance of a course with free timing and therefore a lot of own responsibility is high as well as the readiness to learn in spare time and in addition to daily duties. [1]

2.2. Design of Learning phase

In the learning phase, factual knowledge is provided via eLearning modules that offer the opportunity for an individual organization of learning for each participant, adapted to his specific needs, interests and velocity of learning. During the self conducted work on the modules, a tutor is always available for support. The tutor needs experience and skills in measuring as well as pedagogical competencies, to support the learners adequately. If any questions occur during the work on the learning modules, the tutor can be contacted.

In the workshops the theoretical contents of the learning modules are discussed and trained in practical exercises to impart procedural knowledge. This transfer of theory into practical work and the linking of theoretical information with own experiences is very important for the correct use of the gathered knowledge in the daily duties of the participants, as only the application of information is able to evidence, if it was really understood. Questions or lacks of understanding can be cleared immediately either by the tutor or by other participants.

Hence, the workshops provide the possibility for direct feedback between learners and tutor and for exchange and social interaction among the participants. This supports the atmosphere of being in a course and reduces the problem of feeling left alone when working on difficult new contents. Also the exchange among operators with different professional background can lead to a spreading of experiences and best practice examples and therefore has a direct impact on the quality of daily work as well as on the motivation to attend the course.

2.3. Design of Project phase

For the phase of project work, a task is set for each participant. The project is chosen in cooperation with the employing company and consists of a subject, which is abundant to the usual daily duties of the participant and thus requires using the newly gathered skills to solve the problem. Thereby the learning process is enhanced and the readiness to accept and transfer new information to improve the usual work is increased. Also, by the solving of a problem relevant for the company, the benefits of the newly gained competencies become visible immediately.

During their work on the project, the participants always have the possibility to fall back on the tutors, if any questions occur. So the transfer of the provided knowledge can be eased. In the workshops during the project phase the learners present their tasks, regarding the currently reached state and occurring problems. Thus, additionally soft skills are trained, such as presenting results of work and discussing possible ways of problem solution. By the presentation and discussion of different tasks, the participants are encouraged to exchange experiences and provide a pool of ideas. So they also can take profit out of the others' tasks.

Working on the project basically supports the transfer of theoretically understood information into practical use. But it has impact, too, on the surrounding of the measuring operator. As metrology never is an isolated task but is closely connected to other areas in the organisation, such as construction, manufacturing or quality assurance, colleagues and cooperating persons become aware of the work on the project, as it is out of routine. This promotes the exchange of information and thereby also the spreading of knowledge. So the participants act as multipliers of knowledge in their organisation and can actively help to improve the cooperation between the different sections to produce high quality products. Thus, a transfer of knowledge is promoted, enhancing a sustainable effect of learning.

3. CONTENTS OF THE COURSE

The course Mess-iN consists of 12 modules covering fundamental principles of manufacturing metrology and corresponding standards as well as properties and applications of various measuring technologies. Additionally methods and basic principles of quality management, in which the gathered measurement results are to be used, are imparted together with general requirements and activities for the achieving of precise, comparable measurement results.

The contents of the course are based on the results of the former European project METROeLEARN, a pure web based course targeted for the education of engineering students in manufacturing metrology [2]. The topics analysed there to be necessary for a compulsory training in metrology were used as framework for the choosing of contents for the course Mess-iN, amended by a module containing basic knowledge of important terms, mathematics and geometrical product specifications in technical drawings. Choosing contents that are not limited to the pure explanation of metrological principles but also include more general topics of quality management, shall rise the awareness of the metrologists for their responsibility for contributing to high quality results.

Dependent on the complexity of each topic, the modules require a different amount of work. Of course this is only a rough estimation, as the actually necessary time depends a lot on the personal abilities and properties of the learner and the preknowledge regarding the specific subject. The course content with the total workload of each module and the timetable is shown in the table below. All in all, the course is spread over a whole year.

Table 1: Schedule of learning content

	Date/Period (in weeks)	Content		Workload
Learning Phase	1st	Start workshop learning phase Introduction to course structure and learning platform		8 h (on 1day)
	2nd-3rd	1 Basic knowledge		18 h
	4th-5th	2 Traceability of measurement results		18 h
	6th-9th	3 Coordinate metrology		22 h
	10th-12th	4 Form testing		14 h
	13th	1st Thematic Workshop Practical exercises for modules 1-4		16 h (on 2 days)
	14th-15th	5 Surface testing		14 h
	16th-17th	6 Optical measurement technologies		14 h
	18th	7 Metrology in quality management		6 h
	19th-20th	8 Inspection planning		10 h
	21st	9 Quality assurance of measurement results		4 h
	22nd	2nd Thematic Workshop Practical exercises for modules 5-9		16 h (on 2 days)
	23rd-26th	Definition of projects		
Project Phase	27th	Start workshop project phase Presentation of project tasks		8 h (on 1 day)
	28th-30th	Project conduction (ca. 40 h)	10 Measurement rooms	5 h
	31st-35th		11 Machine tool testing	10 h
	36th-39th		12 Special applications	8 h
	40th	3rd Thematic Workshop & Interim workshop project phase Practical exercises for modules 10-12; Presentation and discussion of interim project results		16 h (on 2 days)
	41st-51st	Project conduction		ca. 40 h
	52nd	Final workshop Repetition of all modules; Presentation of project results Examination for Certificate “Certified Metrologist”		16 h (on 2 days)

4. TECHNICAL REALISATION

The learning contents of the course Mess-iN are provided via a web-based learning system on the platform ILIAS. The platform features numerous functions, which enable a good communication among the participants and between participants and tutors. Nevertheless, the use of the platform is easy, even for persons not used to browsing in the internet. There are discussion forums, an integrated email system and a group system, that allows for cooperative working.

The modules are presented in the platform and can be used there. The information is presented by explanatory texts enlivened with plenty of graphics and animations. New terms are defined in a glossary and the given explanation will be shown, if the term occurs in the written text. The learners can work on the modules online and parallel or later take contact with each other or with the tutor via the different communication facilities of the platform. But also a version for offline learning or printing out is provided. So the learner does not have to be connected to the internet or has to work on a computer all the time. Additionally, for each module a working sheet is available, containing exercises which require the use of new information as well as its linking with other data and with existing knowledge. These are to be sent to the tutor who correspondingly may give an individual feedback to the participant.

By the coherent presentation of learning materials, tools for cooperative working and communication, the web based learning platform builds the centre of the course and is used as the main facility for exchange and learning.

5. DISCUSSION OF CURRENT RESULTS AND OUTLOOK

The first experiences gathered in two pilot courses with participants mainly from small or medium-sized companies clearly show, that there is a broad interest in a basic training for measuring operators, although there were some retentions regarding the self conducted learning in the web based platform. The average participant is not used to advanced training in the scheme of life long learning and has little or no experience in the field of eLearning or internet use in general. Nevertheless, the learners adjusted well to the training concept and were able to handle the platform easily. To show up opportunities or need for improvement of concept or implementation of the provided training, comprehensive measures of evaluation were conducted [3].

Generally, the feedback of the participants was positive. Suggestions for improvement out of the first pilot course, e.g. the wish for a printable version of the modules, were implemented in the second course and receipted very well. Thus, in the final evaluation after the second pilot course very satisfying results were gathered regarding both the concept of the course as a whole and the applicability of the gathered knowledge. The participants pointed out that many initially existing problems regarding reproducibility of measurement results could be smoothed out. This positive effects on the execution of their tasks has to be considered as an important condition for the sustainable application of the newly gained competencies and the further enlargement and maintenance of the gathered knowledge in respect to life long learning.

Especially impressive are the results gathered in the projects. The desired impact of the project work on the surrounding was strongly noticeable. Many participants gave account about discussions with colleagues following their activities in the project. The feedback in the companies was noticed to be very positive and quite often substantial changes in methods of measuring and quality management as a whole arose out of the newly gathered knowledge, spreading also in other departments. Therefore most participants identified strongly with the success of their project and were willing to contribute large amounts of their spare time.

Due to the positive resonance, after the project conclusion the course is now offered on a commercial basis which was accepted very well by potential participants and employers. So it can be concluded, that the developed course successfully shows a possibility for the integration of learning into work and thereby contributes to the transforming of the former antagonism of working and learning into a mutual support. Thus it offers an efficient way to enhance the continuous improvement of reliability of results in industrial metrology.

6. ACKNOWLEDGEMENT

The authors would like to thank the European Commission for gratefully supporting the project Mess-iN within the framework of the European Social Fund (ESF).

7. REFERENCES

[1] Weckenmann, A.; Werner, T.; Beetz, S.: User needs analysis. In: Weckenmann, A.; Blunt, L.; Beetz, S.: European Training in Coordinate Metrology. Universität Erlangen-Nürnberg, 2005 – NA beim BIBB (ed.): Reihe „impuls“, Heft 20.

[2] Soellner, J.; Weckenmann, A.: METROeLEARN – a new approach for training in the field of manufacturing metrology, VDI-Berichte 1860. Düsseldorf, VDI, 2004.

[3] Weckenmann, A.; Werner, T.: Blended learning course Mess-iN – Integration of work and learning in advanced vocational training for metrology, 34th SEFI Annual Conference: Engineering Education and Active Students, Uppsala, Sweden, 2006.