

# Quality indicators for innovative teaching systems and learning environments in the technology sector for vocational education (with the example electromobility)

„Werkbank und Wissenschaft gehen aufeinander zu. Von dieser Kooperation profitieren beide – Handwerker und Akademiker – gleichermaßen. Das Wissen und Können der Handwerker wird um fachtheoretische Aspekte erweitert; Akademiker bekommen einen Einblick in die handwerkliche Herangehensweise an die Elektromobilität. Zweifellos ist dies nicht zuletzt im Hinblick auf die Notwendigkeit, europäische Lösungen zu finden, ein zukunftsweisendes Modell.“

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## Learning environment and quality indicators - introduction

The objective of our project „Learning e-Mobility Plus“ on the one hand is to demonstrate possibilities for the cooperation between vocational schools, science/research and business practice. On the other hand it aims to build up practicable learning environments that implement technological requirements practically and, thereby, connects vocational education closer with higher education/research - with the example of the future technology electromobility.

So far, electromobility is not part of the education in vocational schools, high-voltage technology is only taught in higher education. Thus, there is fear of contact. However, skilled workers in the motor vehicle sector need more and more competences in handling electromobility (installation, service and sale of hybrid and electric vehicles).

With the pilot of our learning environment electromobility and the practical learning models, the corresponding contents should be prepared for the vocational school level in order to integrate them in relevant training courses in the medium-term.



*Testing of the learning models in Poznan*

To ensure a high quality of these new learning environments from the beginning, we plan a quality check on the basis of indicators that were developed for this learning environment and, afterwards, will be available for the vocational schools for the quality assurance.

This documentation sums up the results of our analysis and examines the quality indicators for a learning environment in the technology sector with the example electromobility and how they can be measured. Additionally, we provide a quality checklist - a template for the regular monitoring of these indicators.

## Definitions

### Innovative learning environments

Collaborative working of diverse training and education institutions and actors with different levels in vocational education, who have different expertise and follow the development of a common object/result - with the example of the future technology electromobility. The innovative learning environment's objective is to strengthen the quality in the vocational and higher education, in accordance with the requirements of the job market in the area electromobility and securing of competences of junior employees and the acquisition of new competences (motor vehicle/electromobility, energy).

The approach of the strategic partnership: "Reengineering" - users provide impulses and implement them by themselves in the development ("setting back effect" - „Zurückfließende Wirkung“).

Working instruments: meetings/common templates, documents/working groups (working group apprentices-students, working group vocational schools-companies, working group vocational schools-universities)

### Learning outcomes

Learning outcomes are knowledge, skills and/or competences that one person acquired and/or is able to prove after passing a formal, non-formal or informal learning process (CEDEFOP, 2008).

### Quality

After EN ISO 9000:2008 (the valid standard series of quality management), quality is defined as "level, in which a sentence of inherent characteristics fulfils requirements". Thus, the quality indicates, to what extent a commodity or a service corresponds to the consisting requirements. There are numerous discussions about the definition of the term quality. In the field of vocational education we use the interpretation of Horst Mirbach. He deduces quality legally from the objective formulated in §1 of the Vocational Training Act. It says that quality means to transfer vocational skills, competences and capabilities, which are necessary for the changing working environment and are also the key elements of vocational capacity for action, in an organised training course.<sup>1</sup> However, to measure quality is one of the biggest challenges in the educational sector.

### Quality indicators

In accordance with the definition of the OECD, an indicator is a quantitative or qualitative factor that allows the simple and reliable measurement of the achieved and the results. It demonstrates the changes that are connected with an intervention and helps to assess performances. Thus, a quality indicator is a tool to measure the quality of a process or a product (commodity or service). Indicators provide information, to what extent agreed quality objectives were reached or not reached<sup>2</sup>. Indicators are ideally defined, when they are appropriate to their purpose and practicable for the target group.

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<sup>1</sup> Horst Mirbach - In: Qualität in der beruflichen Bildung: Forschungsergebnisse und Desiderata; Hans Dieter Münk/Reinhold Weiß [Hrsg.]; Bielefeld 2009, S. 59-68 and Der "Qualitätsbegriff" in der beruflichen Bildung / Horst Mirbach. - Bonn : Bundesinstitut für Berufsbildung, 2007. [www.kibb.de/cps/rde/xbcr/SID-2BAB13DE-6F2862CB/kibb/Vortrag\\_mirbach.pdf](http://www.kibb.de/cps/rde/xbcr/SID-2BAB13DE-6F2862CB/kibb/Vortrag_mirbach.pdf)

<sup>2</sup> See also: Handbook for VET providers; CEDEFOP; 2015; S.26

## Framework conditions and analysis

In the framework of the project a situation analysis was made in the three involved countries Germany, Italy and Poland regarding

- teaching systems/learning environments in the vocational education (with a focus on the motor vehicle sector)
- central adjusting crews for an improved activity orientation in the learning process
- integrating future technologies and the usage of findings from science and research in the area of vocational education
- possibilities for collaborative learning of apprentices and students and the interlinking between vocational education and university/research
- participation of innovative enterprises and
- strengthening the reference to the requirements of the job market

### **The following central questions have been examined:**

- How can quality be measured?
- What are the framework conditions for the development of activity oriented learning environments?
- What are possibilities for collaborative learning (in the areas vocational schools and universities) in the framework of the present systems?
- Where can currently inhibiting factors for collaborative learning/cooperation/interlinking be found?
- Where are the weaknesses of currently existing learning systems in transferring complex learning contents?

For the analysis of previous framework conditions and possibilities for influencing the increasing of the education offers' quality of the motor vehicle sector, the project partnership investigated the following issues:

1. Anchoring technological innovations (hybrid/electromobility) in the teaching and learning materials in the motor vehicle sector
2. Status of the current cooperation between SME/university/vocational schools
3. Perception of further education regarding the technological progress by the SME/VETPROs/professional teachers (importance in practice)
4. Support of responsible authorities

For this, standardized questionnaires for all three target groups have been developed. The following inhibiting factors/weaknesses of current learning systems in Germany, Italia and Poland have been stated in the conducted surveys:

1. In vocational schools, electromobility is handled only marginally. If it is part of it, primarily the theoretic learning is in the focus, rarely the practical learning. Fundamentals of electric motors are also part of the vocational education for electricians.
2. In practical vocational education, motor work benches are used in the repair shops. Normal maintenance works are executed and special services are simulated on them. Electric and hybrid motors are rare in the educational areas of the vocational schools.
3. Although engineering science oriented faculties start to offer seminars on electromobility, it is still a less covered topic in universities.

4. That is why there is learning material, which particularly has been developed for higher education, experimentation and research. It barely concerns the normal maintenance works of qualified personnel.

5. The cooperation between university and vocational schools is restricted. Therefore, there is no active collaboration for the benefit of the common development of action-oriented learning environments.

6. The cooperation between SMEs and universities is not strongly developed, too. There is an example from a survey of motor vehicle companies in Poznan: 93% of the SMEs confirm that there is only barely or not at all a cooperation (regarding to the technological developments; excepting only big car companies). 7% stated they participated in various further educations concerning the technological progress (hybrid/electromobility).

#### CONCLUSION:

Generally it can be stated for all partner countries that the vocational and academic education are running next to each other. Furthermore, there is a second barrier that will not be supportable in the long-term: there is a fear of contacts regarding topics with electrical contents, applying both to vocational teachers and educators.

#### Possibilities

At the same time, potentials of possibilities for collaborative learning (in the sectors vocational schools and higher education) that the present systems offer, have been analysed. Additionally, they are classified as good practices.

## The three quality indicators for an innovative learning environment

After a multilevel discussion process, the partnership defined three central indicators for a successful learning environment in vocational education:

Indicator 1: Active cooperation  
Indicator 2: Applicability  
Indicator 3: Transferability

For an in-depth analysis it is possible to set up further quality indicators. For our innovative learning environment we limit the number of quality indicators to these three central ones in order to keep the system of assessing quality clearly and to not overextend the capacities of the vocational schools. Each of the three indicators is examined on the following pages.

### Indicator 1: Active cooperation

A significant characteristic of our innovative learning environment is the collaborative working of diverse actors in order to make available a diversity of expert knowledge and competences for vocational education. This not only means the commitment to work together, but also the practical realisation in the daily educational work. We call this “active cooperation”.

Characteristics of such an “active cooperation” are:

<b>Well-functioning working groups</b> <ul style="list-style-type: none"><li>- Involvement of relevant actors</li><li>- Working plan and clarification of roles</li><li>- Controlled team building</li><li>- ...</li></ul>	<p>Relevant actors for our innovative learning environment are educational organisations (vocational schools and universities), actors of the job market (SMEs) and regulatory authorities (chambers and administrations as well as, finally, the trainees themselves (both the apprentices in vocational schools and students in the university).</p> <p>For our learning environment we establish three kinds of working groups:</p> <ul style="list-style-type: none"><li>- working group apprentices-students</li><li>- working group SMEs-vocational school</li><li>- working group vocational school-universities</li></ul> <p>The pilot phase in Berlin focuses on the working group vocational school-universities. This working group also takes care of the arrangement of the working group apprentices-students</p> <p>The partners in Vicenza focus on the working group SMEs-vocational school.</p> <p>The main emphasis in Poznan is put on two working groups: SMEs-vocational school and vocational school-universities</p>
<b>Regular meetings</b>	<p>Scheduled meetings in the pilot phase every 4 weeks, later meetings every 3 months are planned</p>

<b>Efficiency of the teams</b> <ul style="list-style-type: none"> <li>- Development of joint solutions for educational offers/methods</li> <li>- cooperative development of materials by using different competences</li> </ul>	<p>The members of the teams in every country in our pilot together develop concepts for the construction of learning models for electromobility (with booklets on duties and responsibilities, each for every country). The construction of the models is made together with the trainees.</p> <p>There is a special challenge for the working group apprentices-students, as they self-reliantly work on the solutions - with teachers in the role of advisors.</p> <p>A coordinated PR-strategy, the collaborative organisation of multiplier events and mutual support in PR-actions are also part of the team's tasks.</p>
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## Indicator 2: Practicality/applicability of methods, tools and materials

In education the target group orientation, means the orientation on the preconditions and needs of the trainees, is a central factor of success. Thus, the target group trainees is the starting point for our definition for practicality and applicability. Methods, tools and materials are only good when they have the greatest possible benefit for the end user. This means that the apprentices and students have to understand and have to be able to work with the tools and materials. The teachers as intermediaries in the learning process have to be qualified to work with the tools and materials and to use appropriate methods in order to transfer learning contents effectively.

On the level learning materials, methods and tools, practicality and applicability include the following characteristics:

<b>Clearly defined learning objectives</b> <ul style="list-style-type: none"> <li>- Learning objectives for the concrete target group, taking into consideration the preconditions of the trainees (previous knowledge, understanding of methods)</li> <li>- Competences of teachers handling the learning environment</li> </ul>	<p>The learning models/learning environments are oriented towards the learning objectives defined in the vocational programme and put them in more concrete terms. They focus on central skills that are necessary in handling high-voltage technology. There is a consensus that teachers have to be able to handle the learning models/learning environments to successfully manage the learning process. Relevant training requirements for the teaching staff will be discussed in the working groups. For this, a guideline on how to use the learning environments for the teaching staff will be developed.</p>
<b>Scientific requirement and topology</b> <ul style="list-style-type: none"> <li>- Technical progress</li> <li>- Reference to the job market</li> </ul>	<p>When developing the three models in the pilot, there is a great emphasis on illustrating high-voltage technology close to reality. This also includes to make the current status of the technology a subject of discussion and to show, in which fields further technical developments are expected. The relevant norms and standards are named (here it is important to keep the norms and standards in the working sheets always up to date). Real working processes serve as role models for practical exercises (such as the processing of a repair order in a motor vehicle repair shop).</p>



<b>Comprehensibility</b> <ul style="list-style-type: none"> <li>- Clear structure</li> <li>- Visualisation</li> </ul>	Target group orientation also means that the tools and materials are understandable. Thereby, comprehensibility is not in conflict with science (see above). A clear structure and a good visualisation are important aspects for this. In technology, visualisation can be realized well through graphics and wiring diagrams, complemented with photos and videos. In the project we implement this with our multimedia documentations.
<b>Activity orientation</b> <ul style="list-style-type: none"> <li>- Interactive methodology participatory design</li> <li>- Promotion of self-reliant and cooperative working</li> <li>- Good handling of the tools</li> </ul>	A successful activity orientation means that learners take responsibility for their own learning process, they organise themselves, are able to work in a team as well as to develop and apply problem-solving strategies. Our learning models and the accompanying materials are designed in a way that they support self-reliant working and cooperation in a team. The learners are required to plan working processes with several steps, to estimate consequences and to consider action alternatives. We take care of a good handling.
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### Indicator 3: Transferability

The effectiveness of an innovative learning environment is also measured in the way how well it is possible for others to utilize it. Thereby, we consider the possibilities of a European wide dissemination (geographical transfer) and possibilities of the application in other professions/branches (sectoral transfer). In the course of the geographical transfer we expect a need for adaption with a view to legal framework conditions and specifics of training professions. Concerning the sectoral transfer (in the first step the possible use for related training professions/branches: electric, machinery and plant engineering; in the second step the use in less related branches) in our opinion there will be a bigger need for adaptation as the structure of the learning environment has to be filled with other contents. Under the heading of “European dimension”, the quality of a learning environment is also to be measured by clearly identifying generally valid aspects and country-specific respectively branch-specific elements.

Characterisations for transferability are:

<b>Appropriate documents for the transfer</b> regarding methods, tools and materials <ul style="list-style-type: none"> <li>- Clearly formulated learning objectives</li> <li>- clear structuring</li> <li>- sufficient level of abstraction in order to facilitate geographical and sectoral transfer</li> <li>- spread language</li> </ul>	<p>In the course of the project we develop guidelines for three concrete learning models regarding electromobility with clearly defined learning objectives, booklets on duties and responsibilities and multimedia documentations.</p> <p>The material will be multilingual. Apart from the versions in the national languages for the use in the particular vocational schools and the transfer in the respective country, a (reduced) version in English will be created, which is suited for EU-wide dissemination.</p> <p>Country-specific aspects are also part of the material. For example, the learners get to know national standards that they need for their work. Such specific aspects are clearly indicated, so they can be adjusted for the transfer.</p>
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Third party demand	The demand will be documented in the project. Thus, it becomes clear, what are the needs and what kind of transfer possibilities there are.
<b>Feedback/Evaluation</b>	In our opinion, not only demands are important for the assessment of transferability, but all kinds of feedback from third parties. We plan a number of dissemination activities. In the course of these activities we seek for active feedback. Additionally, an intern evaluation is planned within the project.
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## How do we measure indicators?

What you cannot measure, you cannot control. We have to face the challenge, when we want to evaluate, to what extent our learning environment fulfils the set quality objectives. With regard to the measurement of quality, there is another challenge for the educational sector - competences are not observable or measurable, but reveal in their application in concrete situations. Furthermore, the measurement has to be practicable for the actors - like the indicators themselves.

We propose the following methods for measuring and assessing the quality indicators:

- Observation of the learning process (by the vocational education teacher or other observers of the company or university)
- Questionnaires for teachers, learners, other actors
- Oral feedbacks - individually or in a group (teachers, learners)
- Stakeholder interviews
- Execution of tests

The results of the observations, feedback rounds, questionnaires and tests have to be documented in order to make them available for the further work. In this process, it has to be considered that the capacities of both the teachers in the vocational schools and other actors are limited. A too complex documentation would complicate or even inhibit the usage (no time for writing and no time for reading). Thus, there is the principle: **Keep it short and precise!**

Therefore, we propose a quality check list that briefly presents the results of the measurements, shows the needs for action and specifies ideas for improvement. By using the table format and bullet points, the checklist gets clearly and easy to handle.

We will not use a colour scale (green-yellow-red) for our check list, even though it provides a good visualisation. For example, such a scale is used in the quality check in the BIBB-guideline regarding the quality of vocational education. However, the factors in our check list are more complex and a three-stage colour division is relatively rigid. For our target group this can represent an inhibition threshold for the usage.

That is why we do not use a colour scale. The users can give information on positive and negative aspects without assessing at the same time, whether it is for example "still green" or "already yellow". Nevertheless, we recommend the users to clearly identify urgent needs for action and to

pass it on to the next level of escalation (responsible actors/working groups) for elaborating solutions.

*Example for indicator 2*

<i>Indicator/forms</i>	<i>Scientific requirements and topicality (technical progress, labour market relevance, ...)</i>
<i>Data collection/measurement</i>	<i>Interview/check by representatives of university and SME (oral feedback)</i>
<i>Results</i>	<i>Illustration of the automotive engineering is up to date Skills in the job are useable, the working process is realistic for the use in SMEs ...</i>
<i>Assessment Need for action Suggestions for improvement</i>	<i>Fulfilled Currently there is no need for action, but the technical developments have to be observed ... (especially induction, ...)</i>

<i>Indicator/forms</i>	<i>Interactive methodology, participatory design and guidance for self-reliant working</i>
<i>Data collection/measurement</i>	<i>Observation by the teacher, group feedback at the end of the training unit</i>
<i>Results</i>	<i>Learners actively work with the tools and materials, they ask questions The team organises the tasks itself, the teachers are only needed as advisors (or: teachers must intervene...) Learners assess that they practically can solve the task</i>
<i>Assessment Need for action Suggestions for improvement</i>	<i>Good with potential for further improvements Pay more attention in team work that not only some team members are working, but every learner at least takes on one subtask. This could be emphasized once again in the task sheets</i>

The quality check list is designed openly and can regularly be updated (no doubling). The current status can be seen in the processing date. Previous check lists should be archived. The check list can be further developed by the vocational school in accordance with their capacities and the specific needs. Most important is the regular use!

In our learning environment this check list is tested in the working groups SME-vocational school and universities-vocational school. At later stage, it regularly should be used for the quality check by the responsible teachers of the vocational schools. Furthermore, it should be reviewed each year as well as, where applicable, should be updated and complemented. In the course of this, actors coming from politics, science and research (members of the working groups) support the vocational schools with information. Additionally, the learning environment can be improved with the help of the exchange about experiences with the environment and the quality check list within the transnational network.

## Closing remarks

Successful quality assurance and development is a continuous systematic process. The actors have to keep up the course!

Quality constantly has to be checked and, when there is a need for action, changes have to be initiated. Quality assessment is only useful, when conclusions for a are drawn and the lessons learned are put into practice concretely. This task in quality assurance is the most difficult one (and unfortunately the weakest). In order to realize the engagement of all actors it is important to always make available the results of the assessments and to encourage all groups to have open discussions.

## Sources and further literature

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Qualitätssicherung beruflicher Aus- und Weiterbildung (BIBB, wissenschaftliche Diskussionspapiere, Hefte 78, 2006)<sup>9</sup>

Conclusions of the council quality assurance in vocational education<sup>10</sup>

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<sup>3</sup> [www.cedefop.europa.eu/files/3068\\_en.pdf](http://www.cedefop.europa.eu/files/3068_en.pdf)

<sup>4</sup> [www.cedefop.europa.eu/en/publications-and-resources/publications/4106](http://www.cedefop.europa.eu/en/publications-and-resources/publications/4106)

<sup>5</sup> [www.deqa-vet.de/\\_media/ENIQAB\\_Broschuere\\_deutsch\\_neu.pdf](http://www.deqa-vet.de/_media/ENIQAB_Broschuere_deutsch_neu.pdf)

<sup>6</sup> [www.cedefop.europa.eu/en/publications-and-resources/publications/5167](http://www.cedefop.europa.eu/en/publications-and-resources/publications/5167)

<sup>7</sup> [www.cedefop.europa.eu/en/publications-and-resources/publications/1708](http://www.cedefop.europa.eu/en/publications-and-resources/publications/1708)

<sup>8</sup> [www.cedefop.europa.eu/en/publications-and-resources/publications/5168](http://www.cedefop.europa.eu/en/publications-and-resources/publications/5168)

<sup>9</sup> [www.bibb.de/dokumente/pdf/wd\\_78\\_qualitaetssicherung.pdf](http://www.bibb.de/dokumente/pdf/wd_78_qualitaetssicherung.pdf)

<sup>10</sup> <http://eur-lex.europa.eu/legal-content/DE/TXT/?uri=URISERV:ef0011>