

# Bridging the gap between high-tech and slow or 'weak' learners

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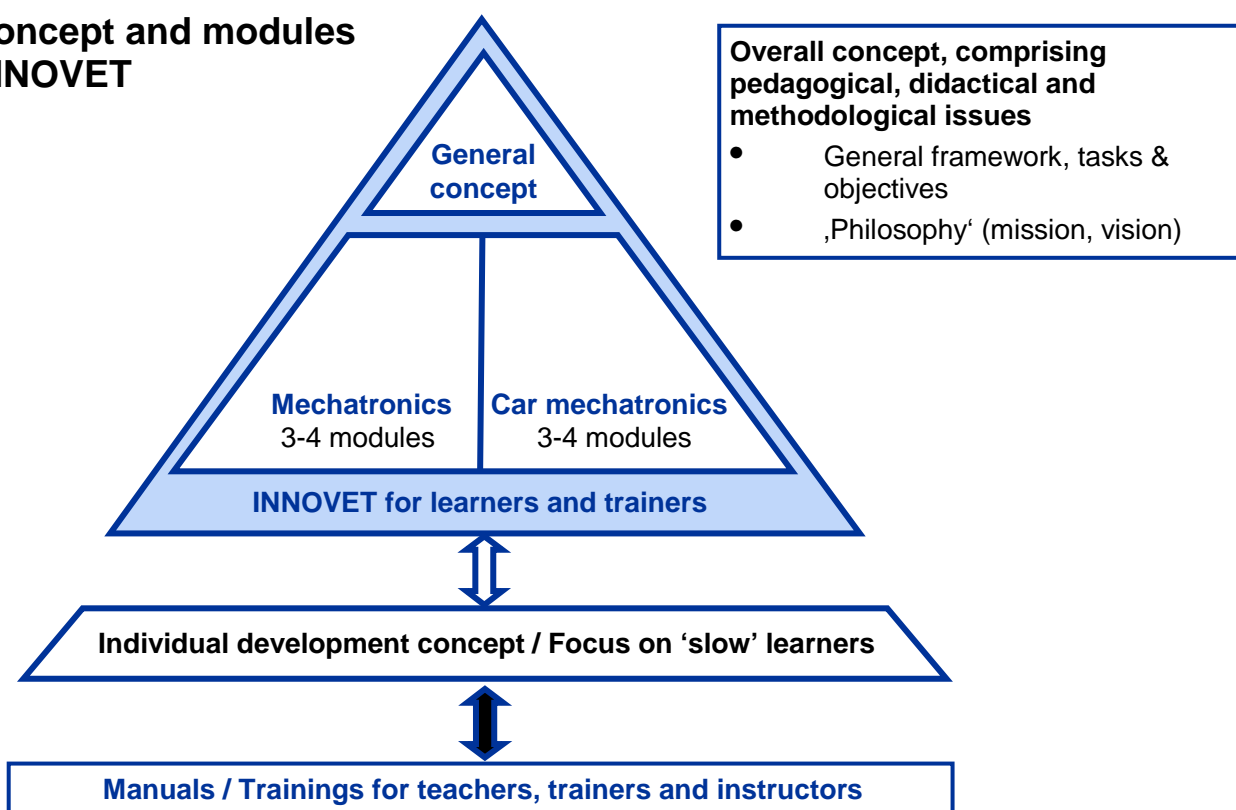
## 1. Preliminary remarks

The implementation of new information and production techniques has resulted not only in far-reaching changes but also established an extensive scope for creativity in the competing interests between work and technology, work organisation, and vocational training. Issues, such as, integration, networking, systems thinking, communication and cooperation are of vital importance. Rapid technical development demands the continuous further development of educational conception, educational targets and contents, as well as suitable educational concepts and material.

Consequently, future-oriented vocational training must take as a starting point peoples' complete personality. The design of appropriate training and learning processes requires a change in the understanding of roles by teachers and learners alike. Considering the broad range of the qualification fields – "mechatronics" and "car mechatronics" – it makes little sense to work on standardised solutions for developing media as well as on the design of teaching and learning processes. Rather, trainers and teachers and teaching staff are required, in particular, to proceed with a flexibility, according to the respective learning group, the individual learning type and different frame-work conditions.

Within the framework of the INNOVET project, focus is on the following key areas of activity:

### Concept and modules INNOVET



**Target groups with difficult learning requirements** should be qualified to implement and use modern technologies and processes. For this purpose, especially when dealing with slow learners, low academic achievers, or those not used to learning, there is a need for **suitably qualified training and further training personnel** to facilitate positive senses of achievement. For the

specialised needs of the target group(s), as part of our project, suitable **training concepts, media and materials** will be developed and tested. **Instructors, teachers and trainers will be sensitised and qualified both pedagogically and methodically/didactically.**

## **2. Inter-disciplinary qualifications in mechatronics and car mechatronics**

Modern qualifications in the occupational fields of mechatronics and car mechatronics aim, primarily, at dealing with modern complex systems, machines, plants and processes with different components and control conceptions. Of particular importance are “the interfaces” between the technical occupational fields, electro and metal – particularly, with regard to clients and customers as the central instance in the commercial sector – and, with regard to methodical, social and creative competences. In vocational training it is therefore a matter of enabling independence when planning, implementation and controlling work processes as well as promoting the readiness and capability to self-directed learning and to continuing/further education. To this end, the concept of **work process know-how** or **learning during the work process** was established (compare summary: Scheib, 2007). Thus it is obvious that “rigid” curricula and framework requirements, and in particular, static general training plans (for enterprises and by extra- and inter training institutions) or training regulations (for schools) indeed present rough policy guidelines. These, however, have to be “translated” by trainers and teaching staff with regard the respective learning objectives and framework conditions, i.e., flexibly filled with content and consequently substantiated and tailored to learners’ needs.

### **2.1 Learners**

Linked to the implementation of challenging educational goals in vocational training, with regard to personnel, special importance is being attached to full-time instructors and training supervisors (in enterprises), teachers (in vocational schools) and other teaching staff (in extra- and inter training institutions, eg. chambers and associations) as well as further educational trainers (multiplication effect). These are – similarly as on the other side, the learners in initial educational and vocational training, continuing vocational education, retraining – the primarily “concerned”, especially when it comes to implementing a new understanding of skilled work or promoting occupational performance competence:

- Independent information gathering / Diagnosing
- Planning,
- Decision making,
- Executing, and
- Controlling, and
- Assessing and evaluation work procedures.

### **2.2 Pedagogical and technical-didactic Issues**

In the debate on how technical systems which are apparently becoming increasingly more complex can be „processed“ in a form suitable for teachers and learners, there is very often a lack of appropriate and transferable approaches in the field of pedagogic, didactics and methodics. We are convinced that the starting point for developing such suitable concepts must follow the actual debate about requirements for (vocational) occupational competences: No longer only skills and abilities in the classical sense but e.g., also the motivation and ability for life-long learning should be suitably promoted and implemented. In addition, there is an abundance of affordable and implementable training media (models for learning and training, materials, media and support for their – pedagogical, specialist and technical – meaningful use), which makes the overview difficult.

## 2.3 Requirements for technical education

In addition to independently planning, executing, controlling and reflecting, the necessary workflow, the tasks that must be carried out either by an individual or a team of specialists also include actively designing the workplace and work organization. In the classical 'primary skilled work', ie in the area of all skills directly relevant to the production line and systems, the emphasis is on the operation and control of modern computerized systems and components. In classical "secondary skilled work" (start-ups, maintenance, troubleshooting and repair), gaining in importance are the establishment, modification and optimization of systems, components and their control with application-oriented programming, testing and diagnostic systems. This "classical" separation, however, appears to be becoming increasingly outdated: They are indeed growing closer together, an example of which is evident in the field of preventive services and maintenance.

To cope with the many tasks and demands which modern and increasingly complex production facilities and procedures bring with them, it is necessary to have a comprehensive and fundamental understanding of the controlled process and production environment (plant or machine with corresponding control or steering). Also necessary is a fundamental knowledge of their work-related and organisational integration in divisional, departmental, and inter-company correlations. Superficial knowledge of operating without an understanding of the induced consequences in the production process can no longer suffice to meet the requirements of the workplace, and give away, on the other hand, a major potential in human skills such as creativity, intuition and the ability to deal with unprecedented situations, and problems (compare here: Cooley, 1987, and Polanyi, 1965)

### Overview: Characteristics of a basic education in information technology

A (basic) education in information technology includes the following aspects:

- An understanding of the handling of modern computer-assisted machines, equipment and plants, an overview of the production, as well as knowledge of the consequences of interventions in the production process or in the overall "vehicle" with its components and subsystems,
- Ability to process tasks independently and responsibly, and to find solutions,
- Motivation to deal with new and changing information and production technological fields,
- Ability and willingness to develop ones own ideas and concepts and put them into practice,
- Willingness for lifelong learning, as well as
- Communication and cooperation skills.

Technical and organizational integration in modern vehicle or production systems requires a multidisciplinary way of working, whereby outdated departmental and specialist thinking has to make way for the benefit of a cross-departmental and interdisciplinary orientation. Hence, in addition to a basic understanding of the entire production process and the functions of all the areas involved, a system-oriented understanding over and beyond the various disciplines is required. Cooperating and communicating with employees from ones own or from other disciplines will take place depending on the scope of tasks and problematic areas at different system levels. This requires a corresponding level of an appropriate use of learning and training concepts, conceptual models, process descriptions and functional considerations

Skilled workers must be able to cope at these levels and to differentiate between the individual levels. They must be able to, e.g., distinguish between a change from subsystems at one level and the change of system levels, and do so not only within their own but also in other related specialist fields.

Whereas the learning process, according to conventional understanding, was dominated for the most part by the instructor or teaching staff, learner-oriented learning processes are characterized

by a high level of activity and creation by the learners themselves, while the instructor or the teacher increasingly and gradually "withdraws" or - better said – takes over other duties. They are, however, not released from their responsibility. On the contrary, they must ensure the individual promotion of learners in the sense described above. They help them to get to know their strengths and weaknesses and to develop or overcome them (Kluger, 1987).

"You cannot teach anybody anything. You can only help them discover it within themselves (Galileo Galilei).

### **3. Requirements for future-oriented vocational training**

Looking at the different qualification criteria under didactic-methodological considerations, we must consequently consider, i.e., the following questions:

- How can the required qualifications under the given learning site and learning group specific framework conditions be conveyed in education and further training? What changes in these framework conditions may be necessary?
- How are the individual qualification criteria under a personality-oriented perspective interrelated?
- Are appropriate approaches to teaching these qualifications derivable from a single pedagogical concept, or at least from "compatible" theoretical approaches?
- Which action concept/term and which psychological or social-psychological concepts on human learning, action and work can we draw upon?
- What image of mankind is based on existing teaching and training concepts?

According to Brödner (1986, 1988) and Bader (1990a/b and 1991) the human-being is understood to be a thinking and acting subject, who acts consciously and purposefully, and with relative autonomy. His psycho-physiological constitution calls for a holistic perception of his environment. At the same time, human beings find through actions which trigger changes in the world around them, the importance again of their own action. This allows them to carry out targeted actions in unstructured or structurally unfamiliar situations without fixed rules, or under situations of uncertainty (compare, e.g., Dörner, 1989; Dreyfus/Dreyfus, 1987 and Weizenbaum, 1976).

#### **3.1 Action-based learning as a central objective**

The aim of vocational action-based learning is to acquire occupational competence. According to Bader, by occupational competence we mean the "structured entirety of action schemes acquired by an individual, necessary to achieve the objectives in an occupational setting and at his disposal partly through his/her own insight/intuition, and partly automated" (Bader, 1990, p.7).

The concept of action-based learning is based on a comprehensive perception of action, which in addition to learning and expanding competence and abilities, as well as practising skills, includes developing the personality of the learner. Human action is characterised, as we know, by aspects such as the ability to independently design things, and the willingness to develop ones own creativity. Hence, action-based learning in vocational education must aim "(...) to create learning opportunities in training/educational and work processes through which individual initiative, personal responsibility, and the original and autonomous wording of tasks and solutions are facilitated "(Rauner, 1987, p. 118).

Consequently, the focus during action-based learning is on the learner with his/her individual learning requirements, learning and working "styles". Aspects such as objectives and content of syllabuses, curriculum, etc. are by no means neglected and are included in the phrasing and explanation of appropriate tasks. In didactic terms, action-based learning has the advantage of there not only being one effective method for imparting specialist content. In fact, it also enables the targeted exposure to (technical) aids (eg computers, control and steering etc.) and dealing

cooperatively, language and content-based, with the issues and problems which occur (for example, when troubleshooting, containing and rectifying failures) and learning and testing these (compare Gudjons, 2008).

In summary, action-based learning is characterized by the following features:

„Activity-based learning

- is based on a comprehensive concept of action which includes creative and design aspects,
- opens up learning opportunities that enable individual initiative, personal responsibility and independent action to solve tasks and problems,
- places the learners with their individual learning requirements at the centre (and not the subject-matter, or the curriculum, etc.),
- involves the learners actively in the planning and design of the learning process,
- supports the identification of learners with the learning subject-matter, learners feel responsible for the success of the learning process,
- including learners in the planning supports the linguistic and substantive handling of the learning subject (Kluger, 1995, p. 120).

In this context, Bader stresses that learning is not exclusively possible only through direct practical action, but can also occur through the mental reconstruction of other people's actions. Essential, however, is the reconstruction. It is, however, not enough to incorporate other people's ready-made cognitions into sophisticated levels of terminology. Instead, they should be understood, or grasped, and then 'translated' into ones own "conceptual system" so that they are internalized for future application.

As consequences for the training and further training sector, we should note, according to Bähr (1989), the following points which serve as benchmarks for a pedagogic and didactical-methodical guideline and, in our opinion, are also essential for the development of a didactical-methodical approach:

1. Holistic learning in projects and in training courses,
2. Active, self-directed learning and action,
3. Self-directed individual work and group-directed team work,
4. Interactive learning in social learning processes,
5. Independent planning of work,
6. Self-control/evaluation,
7. Training a comprehensive qualification for skilled workers (instead of a one-sided focus on only specialist and technical qualifications),
8. Holistic thinking and action
9. Participation and co-designing,
10. Working on complex, problem-oriented content or tasks,
11. Context and situation-oriented combination of content and methods (instead of the dominance of mere content);
12. Methodological competence and problem-solving skills,
13. Dealing with complex multi-dimensional content (instead of purely specialist or discipline-related),
14. Working in different learning and teaching teams,
15. Thinking and acting in systems or complex correlations.

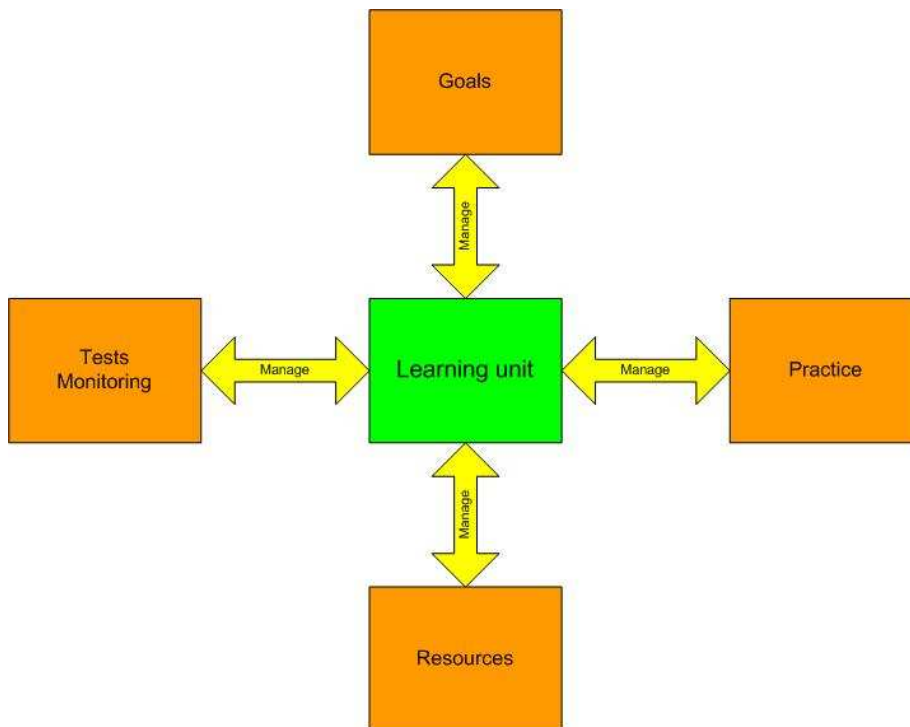
### **3.2. Structure and components of learning units**

A learning unit can be viewed as the smallest section of a course. It consists of at least one initial and one final test, as well as various learning resources, learning methods and learning arrangements (such as books, tasks, film animations, etc.). It should be carried out in the real job world or as close to reality as possible and with an experienced trainer, teacher, trainer or coach (see overview on next page).

## Task-oriented education and training

The classical form of instruction, as everyone experienced during their school days, is often criticized for its lack of efficiency, the frequently inadequate motivation of learners and the frequent overloading of content and approach: As eg., "What still has to be taught before the learner him/herself becomes active? etc. "

### Overview: A learning unit



Merril (2008, see also the following chart, p. 16, on Task-centered instructional strategy) has, in direct contrast to the traditional teaching style, developed a task-centred approach which exactly addresses the above-mentioned difficulties, and in our opinion, is also suitable for the areas of mechatronics and car/automotive mechatronics. The focus, here, is on the actual task ("Task") and the objectives to be achieved. The concept is oriented on the following five steps, each of which is traversed; this cycle is then repeated with increasingly complex tasks and requirements:

1. Describe the complete task.
2. Enter the necessary explanations.
3. Ask learners to solve the task or to recall the learning unit needed (and already taught or worked on) in order to do this.
4. Show how you would proceed.
5. Put what you have learned in an overall context of what you already learned.

## 4. Exemplary reductions to represent typical application areas

For holistic teaching and learning processes it is necessary to create appropriate learning conditions which motivate learners sustainably and grant them sufficient opportunities for action and creativity. At the same time, care must be taken so that traceable references are created for real and typical fields of application, without unnecessary learning barriers, as eg., lengthy, abstract and incomprehensible explanations, complicated operation and complicated operation modes of the components and devices used, and the fear of making mistakes. Additionally, there is the frequent need to remove the existing learning barriers of especially weaker participants.

Compiling a complete job description of mechatronics / car mechatronics is way beyond the scope and resources of the INNOVET project ([www.innovet-mechatronics.eu](http://www.innovet-mechatronics.eu), EU Leonardo da Vinci programme). Given the wide range of modern technical systems and components in both application areas, we decided to identify typical application fields in which we wish to clarify our vocational training "philosophy" to learners and teachers. External resources (professional suppliers of automation solutions and qualified publishers) were included, as well, in the development work of the project. The main focus in the development work is on the following aspects:

- Orientation on typical and realistic systems and components,
- Realistic reflection of typical processes and functions
- Deriving practice-oriented assignment of tasks and possible solutions with varying scalable degrees of difficulty.
- High cost-effective implementation aimed at high transferability and usability of the approach,
- Independent shaping, modifiability and further development by learners and teachers
- High motivation and anxiety-free entry through practical application examples from the working and living environment of the learners.

Here we are dealing with the following ideal-typical application fields, for which, during the project, appropriate units, media, materials and handouts for trainers, teachers, and teaching staff were, or are still being, developed:

## **Mechatronics – Exemplary learning modules**

- I. **Entry Module: "What is mechatronics?"** - The first days in the new field of occupation (construction / control of a simple functional model: eg conveyor-belt, mini-robot)



- II. **Working with assembly groups and components** (e.g. conveyor-belt, processing station, measuring devices/test equipment)



**III. Start-up / Troubleshooting in a complete line**  
(e.g. complete production system)



**Car mechatronics**

**I. Entry Module: "What is car mechatronics?"** -The first days in the new field of occupation  
(visual inspection of a vehicle and simple diagnostic and adjustment )



**II. Working with assembly groups and components**  
(e.g. engine, drive train, brakes, power supply)



### III. **Trouble-shooting / Repair / Start-up of a complete system** (e.g. CAN bus / bus systems)



From a pedagogical point of view, when addressing educational conceptions and media the concern must be on "open systems" which offer a wide scope for individual creativity and modification. Simultaneously, the various aspects and levels of complexity in dealing with modern production systems must be adequately taken into consideration. These requirements must be interlocked with action-theoretical models (compare Volpert, 1985), as well as holistic, non-directive pedagogical guidelines (compare Hinte, 1990; Rogers, 1982; Tausch/Tausch, 1979; for pedagogical conception in PTQ-model tests compare: PTQ Project Group, 1994).

## 5. **Requirements for the training of trainers, teachers and teaching staff**

Due to rapid technological development, trainers, teachers, and teaching staff have, barely enough time to acquire sufficient knowledge to keep ahead of the trainees. Regarding this problem constructively, there is an obvious demand for the direct participation of learners in education and training processes. For complex and multidisciplinary issues, trainers and teaching staff, etc. in any case can not be absolute professional experts. Instead, they more often find themselves in situations where they do not exactly know the solutions to the task and the technical details, and therefore inevitably must themselves perform as learners. Thus, they are increasingly becoming themselves experts in methods.

It is precisely this role of 'trainer as learning role model' ("trainer" is from now on synonymous for the group of persons – both male and female – comprising trainers, teachers, and teachers) for participants in training and further education processes which provides a chance to gain a new and improved access to the different learning groups: Learning to learn has been recognized as an absolute prerequisite for success in later professional life. By trainers actively "living and demonstrating" their role as multipliers, they become recognized partners for learners in the training process, although they need not be absolute experts in all matters, and thus, avoid the dilemma of not knowing all the technical details, or of not being able to solve, "off the cuff", all the questions and problems that arise. They should also, in fact, be role models when it comes to problem-solving skills and how to deal with unfamiliar situations and challenges.

The changing role of trainers results, on the other hand, in the need for involvement of trainees in the design of learning process. These mutual and cooperative design activities by trainers and trainees are also described as the principle of participation (see Hellwig/Tepper/Richter, 1989). A consequence of this for the further training of trainers is that it must be both goal- and process-oriented, so that the experience of problems, resistance and solutions as an individual, or even better, as a team can be accompanied with common didactic orientations and issues.

Learners' autonomy, which is an important educational goal, can be achieved, precisely, by a cooperative partnership between teachers and learners. Independence cannot develop if it is not integrated into the learning process and encouraged.

The further training of trainers should, similarly, as in the training and further education process of learners, take place in cooperative learning and working methods - if and where possible, together with learners – as in this way all the important groups of persons are directly involved in the integrated acquisition of specialist and social skills.

Teachers in vocational training and further education are fully aware of their new role. They express the view that their formal qualifications, including additional skills and gained experience require continuous further development to meet the new self-conception as a multiplier within a holistic and action-oriented educational approach. When articulating their training needs regarding the teaching of future-oriented qualifications in the sense of occupational competence, they increasingly mean social qualifications, as well. These also include, e.g., methods for better work management, independence, teamwork, acceptance and tolerance, as well as social and human behaviour.

The experiences of others can be taken up and further used by the learners so to speak as "help for self-help". They must get this opportunity early in their training to be able to implement their own experiences immediately in conversation and action with others. In this form of teaching and learning process each individual benefits from the knowledge and experience passed on by the others. The individual is forced to compare straight away the new knowledge with his/her own existing knowledge at different levels (specialist, methodological, structural and systemic knowledge, social behaviour, etc.) and link and check them with his/her own experience

Learners can search for links with already existing knowledge and build up their own, individual knowledge structure by putting together individual elements of knowledge into a meaningful knowledge structure. They also have the opportunity to share their own findings quasi in small teaching phases with the others. Heidack uses here the term "mini-instructions" (compare Heidack, 1989, p. 76ff).

The principle of cooperative self-qualification also poses another further opportunity in itself. The group dynamic processes in a teaching or learning team require flexible management of the problems and conflicts which develop in the group. In this respect, it is not just a question of teaching and acquiring expertise, but also about learning from, and with each other, how to deal with conflicts.

Skilled workers in vocational education and training must take on in addition to their planning and preparation tasks in a **concrete action-oriented learning situation** more responsible tasks: The guidance, moderation and the systematization of what is learned.

## **6. Modular training concept: „Train the trainer“**

Anyone involved in training who acquires new knowledge and know-how must be able to put these into practice in a comprehensible and value-adding way as much as possible. Confirmation of successful training is mirrored mainly in improved operational performance. The task of a good trainer is to attune and create learning processes which enable trainees to optimally apply them.

This goes hand-in-hand with the high demands on the trainer: Trainers, nowadays, are not so much knowledge providers as "experts in teaching and learning" who can encourage and accompany different persons in their individual learning processes.

The Train-the-trainer course in **six modules** optimally promotes learning success through a targeted combination of three levels of learning. At the **first level**, participants familiarise themselves with the contents, practise methods and transfer the new knowledge to their own individualised training activities. At the **second level**, the participants reflect on the training approach by reflecting on the effect of the methods and interventions on themselves and by analysing the group process. At the **third level**, the participants continually check their own personal learning progress.

### **Target group**

Persons who actively teach, train and transfer knowledge or who wish to do so, and who would like to develop their trainer competencies, as well as structure and shape their training services more optimally.

### **Module 1: Basics of the training course / Trainer profile**

- Different training types and their demands (product training, behaviour training etc.)
- Role and tasks of a trainer
- Requirement profile of a trainer
- Fundamental psychological models (personality models and typology, inner team)
- Fundamentals of the psychology of learning – Learning style analysis
- Personal skills' matrix – Identifying learning needs and determining specific individual learning goals

### **Module 2: Enabling learning (methods and didactics)**

- Creating learning-conducive basic conditions (room design etc.)
- Didactic basics
- Target group analysis, determining the learning goals, content selection, learning success, measuring learning success, enabling transfer
- Preparing a training design, including getting acquainted with learner-centered methods, esp. for 'slow learners', and with regard to their possible application, being able to assess and adopt them selectively
- Identifying and reducing learning blockades
- Reflecting on opportunities and drawbacks

### **Module 3: Working with Slow Learners: What is a Learning Disability? (3 hours)**

- Facts about learning disabilities
- Common learning disabilities
- How are learning disabilities identified?
- What is effective instruction for students with LD?
- Social and emotional problems related to dyslexia
- Social Skill Autopsies: A strategy to promote and develop social competencies

### **Module 4: Learning patterns of disadvantaged students / Strengthening learning weaknesses (3 hours)**

Mini workshop on how to train slow learners versatile learning approaches as early as possible to enable them to use multiple senses and cognitive skills when learning. To explore methods on not only how to improve their strengths but also their weaknesses

### **Module 5: Facilitating, presentation and group dynamics (3 hours)**

- Preparatory web session

- Developing the trainer's personal power of persuasion (body language, rhetoric)
- Role and task of the facilitator
- Dealing productively with disturbances
- Causes of conflicts and dealing with conflicts (mediation)

#### **Module 6: Final assessment and evaluation (6 hours)**

- Assessing project work
- Moderation and closing of feedback rounds
- Reflecting on personal learning progress and personal learning target achievements
- Feedback and evaluation of the trainer
- Participants' feedback

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