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DEUTSCHE ZUSAMMENARBEIT

Reader for Instruction of Vocational Trainers of Industrial and Technical Trades

Published by:

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Preface

The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH is a global service provider in the field of international cooperation for sustainable development with around 16,400 employees. GIZ has over 50 years of experience in a wide variety of areas, including economic development and employment, energy and the environment, and peace and security. It’s also engaged in international human capacity work around the globe. Our business volume exceeds two billion euros. As a public-benefit federal enterprise, GIZ supports the German Government – in particular the Federal Ministry for Economic Cooperation and Development (BMZ) – and public and private sector clients in around 130 countries in achieving their objectives in international cooperation. With this aim, GIZ works together with its partners to develop effective solutions that offer people better prospects and sustainably improve their living conditions.

Germany’s involvement in international development programmes has a special emphasis on the importance of education on all sectors for technological, economic, social, and environmental development, and the GIZ has thus set Technical and Vocational Education and Training in the central focus of its cooperation projects in many different countries. In this context, the programme *“Promotion of Technical and Vocational Education and Training (TVET) in Afghanistan”* is aimed at improving the situation and conditions of life of as many Afghan youths as possible by enabling them to take part in vocational training schemes specifically adapted to the local conditions. On behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), the programme provides multi-level support in establishing a sustainable and formal, target-group adapted TVET system and in building competencies and resources in the TVET directorate of the Afghan partner ministry.

In addition, the TVET programme in Afghanistan supports traditional company-based vocational training in the informal sector. The programme is developing a strategy that takes this culture-specific feature into due account: Apprentices are enrolled into well-equipped vocational schools. Here, not only the apprentices themselves, but also journeymen and owners of companies are provided with access to state-of-the-art technology and contemporary know-how. Furthermore, the programme aims at enabling cooperation between the representatives of the informal sector and those in the state sector according to the principle of subsidiarity. The intention here is to create an efficient and productive company-based vocational training, in its basic approach comparable with the system of dual Technical and Vocational Education and Training established

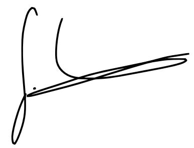
in Germany, which will spare Afghan society considerable investment costs and enable youths to enjoy a high quality of vocational training.

The “**Reader for Instruction of Vocational Trainers of Industrial and Technical Trades**“ offers action-guided information on the planning, implementation and assessing of practical lessons in many different industrial-technical vocations. It also delivers the latest scientific knowledge for the organisation of learning, teaching & learning methods for practical apprenticeship training, learning process control in practice as well as in the complex interaction of didactics and teaching & learning methods. The tasks and questions in repetition at the end of each of the five chapters support to the deepening of the lessons learnt.

In view of our intention to keep this manual as close to the actual needs as possible, we are extremely grateful for the critical and constructive feedback of our readers. The didactical manual is available in German, English, and Dari, in both the printed and electronic form: www.giz.de/de/mediathek/116.html.

Our special thanks go out to all who have made their valuable contributions to this reader.

We wish you an entertaining and successful study of the reader in your teacher training or your independent studies.



Yours, Dr. Gustav Reier

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1. Initiation[1]

1.1 Basic principles for the arrangement of lessons

As a basic rule, don't give lessons without prior planning! Before arranging the lesson, the trainer should analyse the preconditions for the lesson on the selected practical subject. This involves answering the following questions:

- What level of knowledge and which skills do the students already have?
- What kinds of work equipment are available in the classroom?
- What general abilities do the trainees have (such as the ability to read and write)?

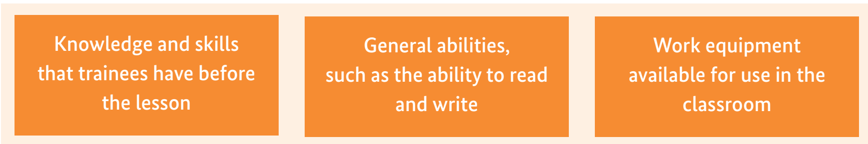


Fig. 1: Learning conditions before the lesson

In addition, the trainer should consider four main areas when arranging a practical lesson. These areas are generally divided into "objective", "content", "method" and "media". Decisions on the lesson need to be made in each of these areas. The four decision areas for the field of work and technology are:

- Objective of the lesson
- Topics in work and technology
- Equipment used in the lesson
- Learning methods and lesson procedure

The trainer needs to consider these areas in order to implement the lesson.

The four decision areas are highly interrelated (Fig. 2). No single area stands alone, as they have a mutual influence on each other. Any changes to one area will also involve changes in the other areas.

1 The generic masculine primarily used for the sake of readability includes both female and male persons.

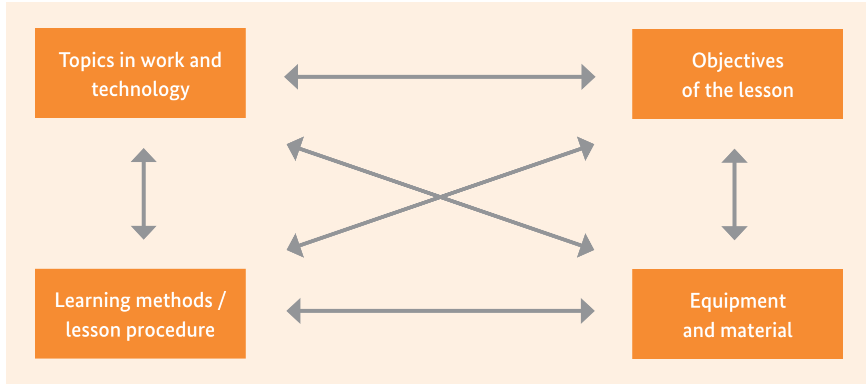


Fig. 2: Interdependence of the four areas for arranging lessons

When teaching a practical lesson, the trainer cannot cover every topic in the complex world of technology. Therefore, the number of topics needs to be reduced and the content simplified. Topics must be selected that are relevant for the craftsman.

Topics /content	Objectives	Methods	Work equipment/Media
The preparation of the welding area has a major influence on the strength of the joint	Trainees perform welding tests professionally and to achieve an accurate result. They understand the basic principles of welding. They must cooperate with one another.	Coopera-tive techni-cal experi-ment	Information sheets, metal sheets, welding machine, electrodes, protective shield, wire brush, chipping hammer, protective gloves, testing machine for pulling test

Fig.3: Sample description of decision areas

Therefore, it is also essential for the trainer to adapt the topics and content of the lesson according to the trainees' prior knowledge and abilities. In most cases, it is necessary to reduce the quantity and quality of the subject matter. Only then can trainees understand and absorb complex, complicated topics. This makes vocational teaching and learning easier.

This also applies to the other decision areas. Learning objectives should only be set at a level that the trainees are able to attain. Likewise, learning procedures should be organised so that trainees can understand them and use them for orientation. Trainers should set up the work equipment and media so that trainees feel confident to use them. Media should not be too demanding or confusing for the trainees. Usually, the adaptation of objectives, methods and media involves reduction or simplification. This is illustrated in the diagrams below.

There is a wide range of possible content and topics in the world of work and technology from which a selection must be made. The selected content should then be reduced for the practical lesson.

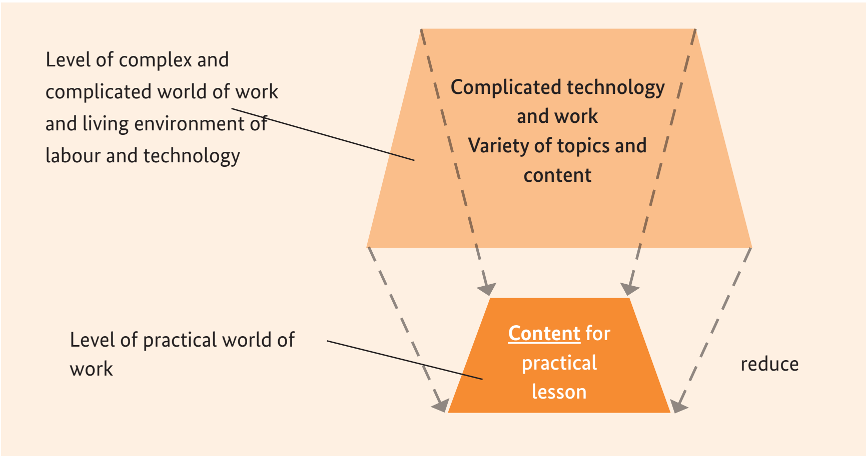


Fig.4: Reduction of complicated technology for subject specific practical lessons

The training objectives that could be considered suitable in a world of work context should be limited for teaching procedures. Select and reduce the objectives so that they are appropriate for a practical lesson.

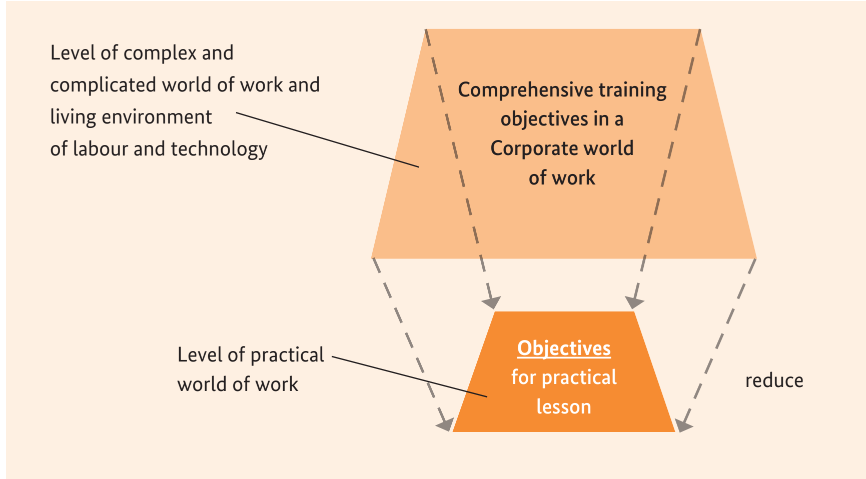


Fig. 5.: Reduction of training objectives

The methods that the trainer selects for the lesson must correspond to these reduced objectives and content. Select methods that are “accessible” for the trainees.

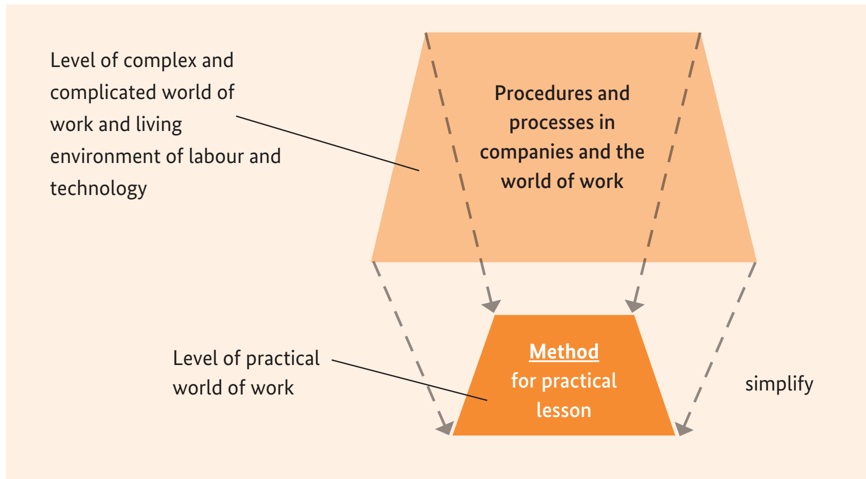


Fig. 6.: Reduction of processes and procedures

There is a wide range of possible media, but simplified work equipment should be selected. These must be applicable in practice and useful for the practical lesson.

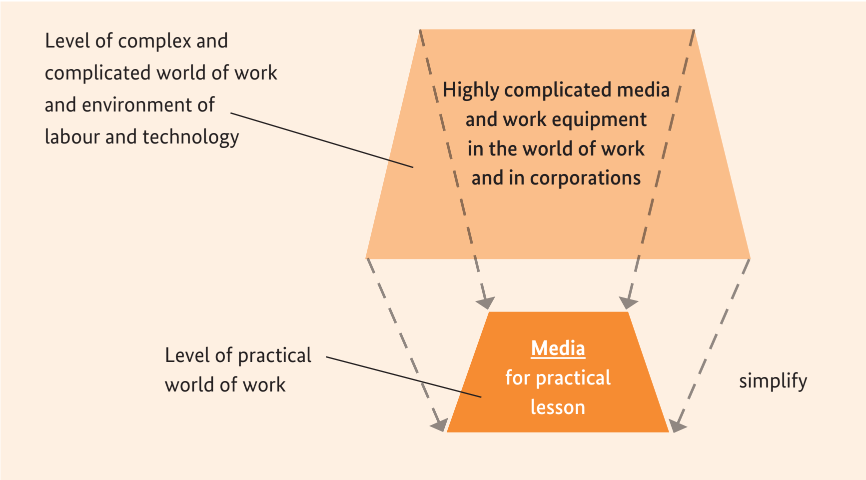


Fig. 7: Reduction of media and work equipment

1.2 Superordinate objectives of the practical lesson

The practical lesson has several primary objectives. These objectives are formulated in a very general manner. However, they apply to all learning processes. To implement these in each lesson, they must be made more concrete.

The superordinate objective of the practical lesson is the acquisition of practical vocational action competence. This includes practical qualifications such as trade-specific skills. Students capable of acting are able to organise their own methods of learning and working. They also have the ability to exchange their opinions with others and to work together with others.

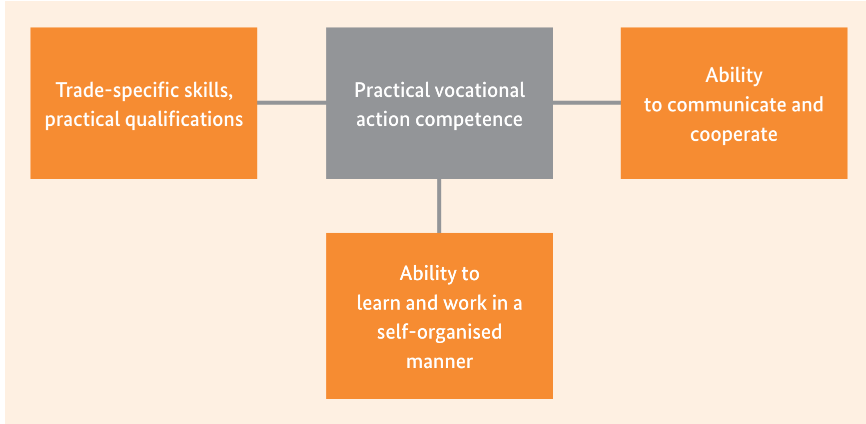


Fig. 8: Elements of practical vocational action competence

1.3 Vocational knowledge and vocational skills

Fig. 9: Vocational knowledge and vocational skills

Furthermore, a distinction must be made between trade-specific practical knowledge and practical skills.

An experienced skilled worker in a trade has fundamental, practical knowledge of the vocation in particular. For example, he or she knows the typical tools and machines that are used in the trade and knows how to operate them.

However, trade-specific practical knowledge alone is not enough for working in practice. Accordingly, the mastery of practical techniques and manual dexterity as practical skills are of great significance.

Only through the interaction between vocational knowledge and vocational skills can vocational action competence be achieved in practice. Only then can the skilled worker solve new, complex problems and progress beyond simple, everyday tasks. Trade-specific practical activities are essential for the didactics of practice. Craftsmanship must be accumulated over the course of a longer learning process. It is often advisable to study individual practical areas of expertise separately. In doing so, trainees can practise psychomotor coordination for specific activities. They will then be able to make use of these skills more readily during their vocational careers.

In order to train manual movement sequences, a rough framework for basic coordination must be established first. As next steps, detailed coordination and finally microcoordination must be cultivated.

Basic coordination: simplified exercise in manual movement sequences for filing a block with large contact area. The actions must be practised so that the file is held straight.

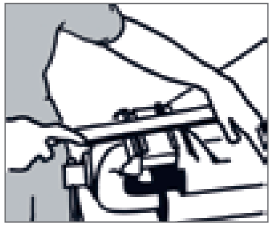


Fig. 10: Basic coordination for filing

Detailed coordination: exercise in filing different positions of medium-sized surfaces of different types.

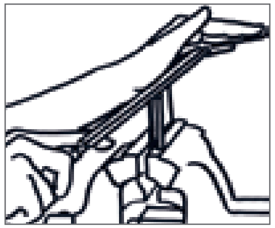


Fig. 11: Detailed coordination for filing

Micro-coordination: exercises in manual movement sequences for detailed abilities when filing surfaces that are small or broken.

Fig. 12: Micro-coordination for filing

As for filing, other manual movement sequences involved in each trade and vocational field are also to be trained in a similar way to allow trainees to practise these skills.

Basic coordination:

First attempts at the manual movement sequences are successful under simplified conditions, but the movement's actions are still imperfect.

↓

Detailed coordination:

Manual movement sequences are successful under normal conditions and errors in the movements are largely remedied.

↓

Micro-coordination:

Manual movement sequences are successful under a wide range of conditions with manifold variations.

Fig. 13: From simple to complex – vocational skills as an integrated concept

In order to build up comprehensive vocational capability, the individual skills that are needed for various manual movement sequences must be practised. After that, they must be integrated into an overall concept of abilities for the trade. By these means, together with a wide range of vocational experience, craftsmanship can be developed.

1.4 Methods for the practical lesson

The word "method" refers to *how* a subject should be taught and learnt. A method can also be described as the path towards a goal.

A learning method is therefore the path towards the learning goal.

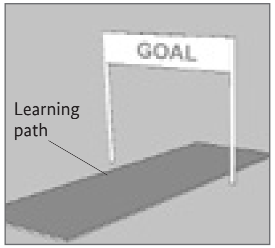


Fig. 14: Method as a path to a goal

There are many different methodological learning paths towards a goal.

These methodological learning paths do not always have to be straight. There are also winding paths and alternative paths. Different methods can be applied.

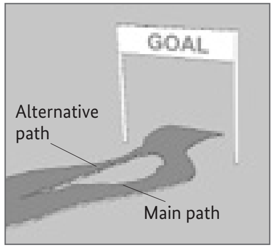


Fig. 15: Methodological path & alternative path

The methodological path usually consists of multiple stages and is divided into many small learning steps. These do not need to be very different in terms of difficulty. If the learning steps are barely distinguishable from one another in level, there is no gradation.

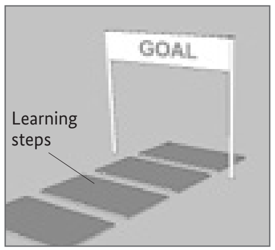


Fig. 16: Division of the methodological path into stages and learning steps

Frequently, the level of demand for trainees rises from learning step to learning step. The steps on the learning path are then staggered. In a minimal structure, there will be at least one introductory stage, a main stage and a final stage. As a basic principle: from the simple to the complex.

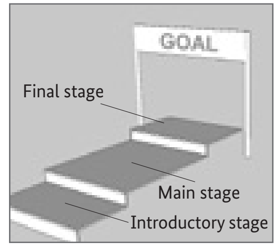


Fig. 17: Stepping of learning steps on the methodological path

These stages and steps should be planned so that learners are not faced with too many demands at once. The basic principle of simple to complex still applies. In addition, the order of the steps should be arranged according to learning methodology. A possible organisation of the steps include: problem setting, formulation of suggestions, problem solution for this case, possible applications for this case, applications transferrable to other fields and generalisation.

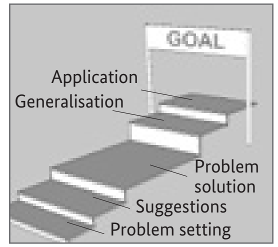


Fig. 18: Staggered learning from the simple to the complex

This method helps learners to orient themselves on the learning path.

Methods in the practical field can be divided into

- exclusively practical lessons
- practical and theoretical lessons
- learning progress tests

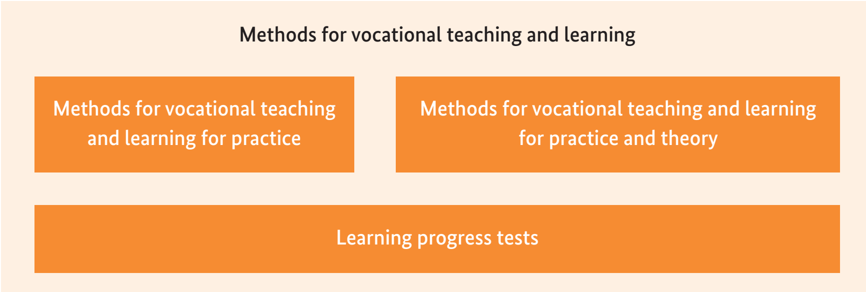


Fig. 19: Methods for vocational teaching and learning in the practical field

A number of methods can be used to instruct practical lessons. These originate in practice in the trades, industrial apprenticeship training and even teaching at school. (Fig.20)

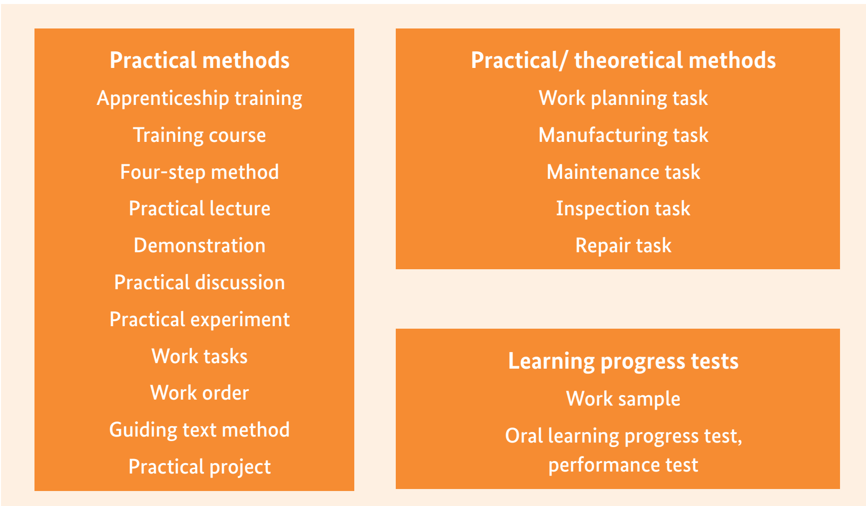


Fig. 20: Methods for practical lessons - an overview

1.5 Work equipment and media

1.5.1 Significance of work equipment and media

Trainees and trainers can obtain technical information from textbooks, trade journals or catalogues. The acquisition of information via electronic media has now become especially valuable for vocational practice. However, original media and equipment have particular significance.

The use of work equipment and media is an essential task for the trainer. Media and equipment serve to increase understanding between the trainer and the trainees. Media are the mediators in the learning process.

Media include language as well as the blackboard, the white board, textbooks, trade journals, worksheets and models. **Equipment** includes tools, devices, facilities, machines and materials, which serve as a means of illustration during the learning process in a practical lesson.

The subject-specific and pedagogically sound use of equipment and media is one of the factors that contribute to a successful lesson.

1.5.2 General non-subject-specific media

The blackboard and chalk is the traditional medium. The advantages of the board are that it is permanent and durable, can be used at any time as needed and does not depend on a source of electricity. Information can be noted down immediately and also erased quickly.

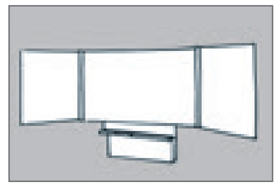


Fig.21: Blackboard

The white board is the modern version of the blackboard. In comparison with the blackboard, images usually have a greater contrast to the background. Also, there is no chalk dust, which can be a problem in rooms with sensitive electronic devices.

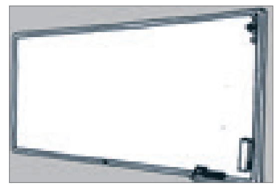


Fig. 22: Whiteboard

A flip chart is like a large notepad (DIN A 1) that is mounted on a tripod. The sheets can either be prepared before the lesson or written on during the lesson by the trainer or the trainees. Thick marker pens with broad line strength should be used for writing. Once the sheets have been written on, they can be referred back to at any time during the lesson.

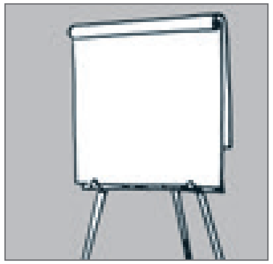


Fig. 23: Flip chart

The overhead projector is a frequently used medium. It allows the trainer to project enlarged diagrams on transparent sheets or models made out of acrylic glas onto a large surface that is clearly visible to the trainees. The sheets can be written on with marker pens. The advantage of the projector over the blackboard, whiteboard or flip chart is that it enables the trainer to maintain eye contact with the trainees.

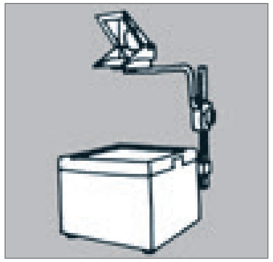


Fig. 24: Overhead projector

Data projectors used with notebook computers have become increasingly important media for presentations in recent years. They can easily be used in the lesson, as they are easy to transport and can store large quantities of data. They can also be used for showing excerpts from educational videos.

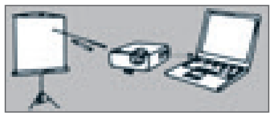


Fig. 25: Projector and PC

With the help of the relevant software, topics in various subject areas can be presented in a very illustrative manner. Also, short videos can be shown to introduce the lesson or to clarify a technical explanation. The Internet is a globally accessible network that trainees can also make use of. The World Wide Web was not originally developed for schools, but for the purpose of making it easier to exchange scientific documents.

1.5.3 Work Equipment

Work equipment for the various vocational fields is very different. This can be illustrated by looking at just a few examples.

Automotive mechantronics

For car mechanics, the original engine can be effective as a medium if they use it for making specific, learning-related measurements.

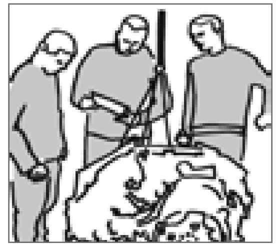


Fig. 26: Trainees observing an engine

Metal construction technicians

For metal construction technicians, a welding machine could represent one type of work equipment that can be introduced in the practical lesson.

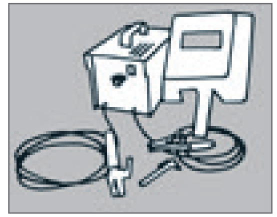


Fig. 27: Welding machine

Machinists/machine technologists

In a practical lesson for machine technology, the principles and functions of mechanical engineering can be visualised using sections taken from real system engineering.

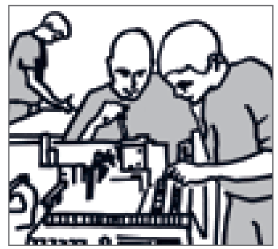


Fig. 28: Examining system engineering during a practical lesson

Sanitary facilities technicians

For trainee sanitary facilities technicians, real objects from their area of specialisation provide trainers with numerous possibilities for discussing the materials, functions and details of the real object.

Fig. 29: Hand Washbasin

Carpenters / Joiners

In practical lessons for Carpenters / Joiners, hand tools can definitely be used for illustration purposes and also for demonstration of their handling or maintenance and care.

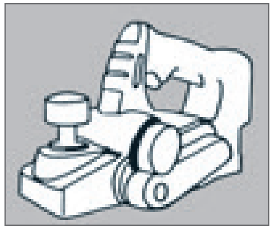


Fig. 30: Portable Planing machine

1.6 Exercises and questions for review and consolidation

1. Which learning conditions must the trainer clarify before planning the lesson?
2. What are the four decision areas?
3. How can the interdependencies between the decision areas be illustrated?
4. Do the decision areas have to be attended in a specific order?
5. When planning a lesson, how can the trainer obtain a better overview of decisions on the content, objectives, methods and equipment?
6. Why learning content must be reduced for the trainees?
7. In which decision areas might reductions have to be made?
8. The content for the practical lesson has to be drawn from the complex world of work and technology. How is this done?
9. How can the objectives be selected so that they are appropriate for a practical lesson?
10. According to which important criteria should the trainer select the methods to use with the trainees?
11. What are the primary considerations for determining which media to use for a practical lesson?
12. What are the superordinate objectives of a practical lesson?
13. What are the important elements of practical vocational action competence?
14. What are the components for competent vocational activities in practice?
15. What are the characteristics of practical knowledge?
16. What is the particularly important function of craftsmanship?
17. Why is basic coordination necessary for work movement?
18. How are exercises in the basic coordination of movement sequences conducted?
19. Describe an exercise in basic coordination of work movement.
20. What is the function of detailed coordination of work movement?
21. What is the function of micro-coordination of work movement?

22. In what order should exercises for the coordination of work movement be organised?
23. According to which methodological concept are the exercises in the coordination of movement sequences for vocational activities arranged?
24. What is understood by the concept "method"?
25. What kinds of methodological learning paths are there?
26. What course might methodological learning paths take?
27. How might methodological learning paths be organised into separate stages?
28. Please identify three fundamental structures on the learning path.
29. What is the superordinate pedagogical principle that can be applied to the procedure for the learning steps?
30. For which practical areas are there methods for vocational teaching and learning?
31. What methods are there for teaching practical lessons?
32. What are the methods for practice and technical theory?
33. What kinds of learning progress tests can be used in practical lessons?
34. What is the function of work equipment and media in a practical lesson?
35. Please name most important media!
36. What are some non-subject specific media?
37. What are the advantages of the blackboard?
38. What can a flip chart be used for?
39. What possibilities are provided by the overhead projector as a medium?
40. Please describe work equipment that can be used in a practical lesson.

2. Conditions and decisions for the organisation of learning

2.1 Interrelation between didactics and methodology

A distinction can be made between didactics in a broader sense and didactics in a narrower sense. Didactics in a broader sense encompasses both didactics in a narrower sense and methodology.

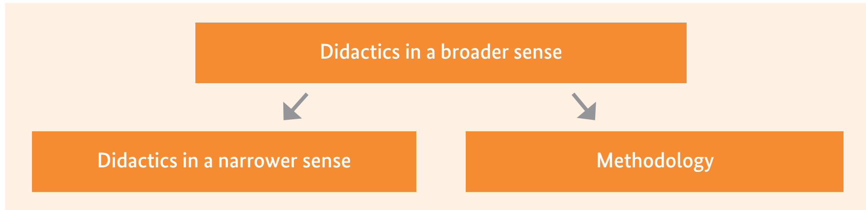


Fig. 31 a: The relationship between didactics and methodology

Didactics in a narrower sense seeks to answer further important questions concerning the "what". It deals with questions about the topics and subject matter as well as the actual learning objectives.

Decisions about the "how", or the learning path, belong to the category of methods. This category involves considerations of suitable methods and work equipment (e.g. tools, machines, materials).

Both categories combined make up the area of didactics "in a broader sense":

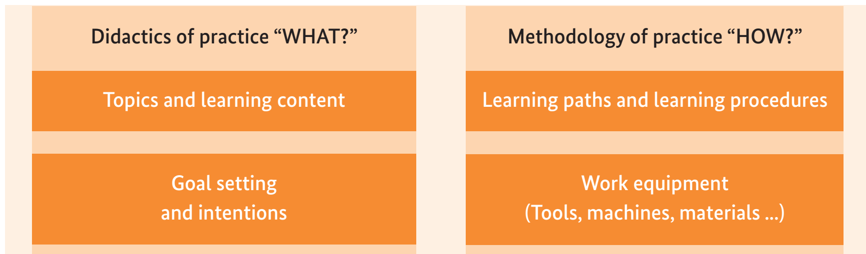


Fig. 31 b: Interrelations between didactics and methodology

A unique didactics develops for each occupation. This is known as “vocation didactics”. This concept includes vocation didactics in practice as a distinctive feature. These distinctions arise due to different focus of professional core activities and the related technology.

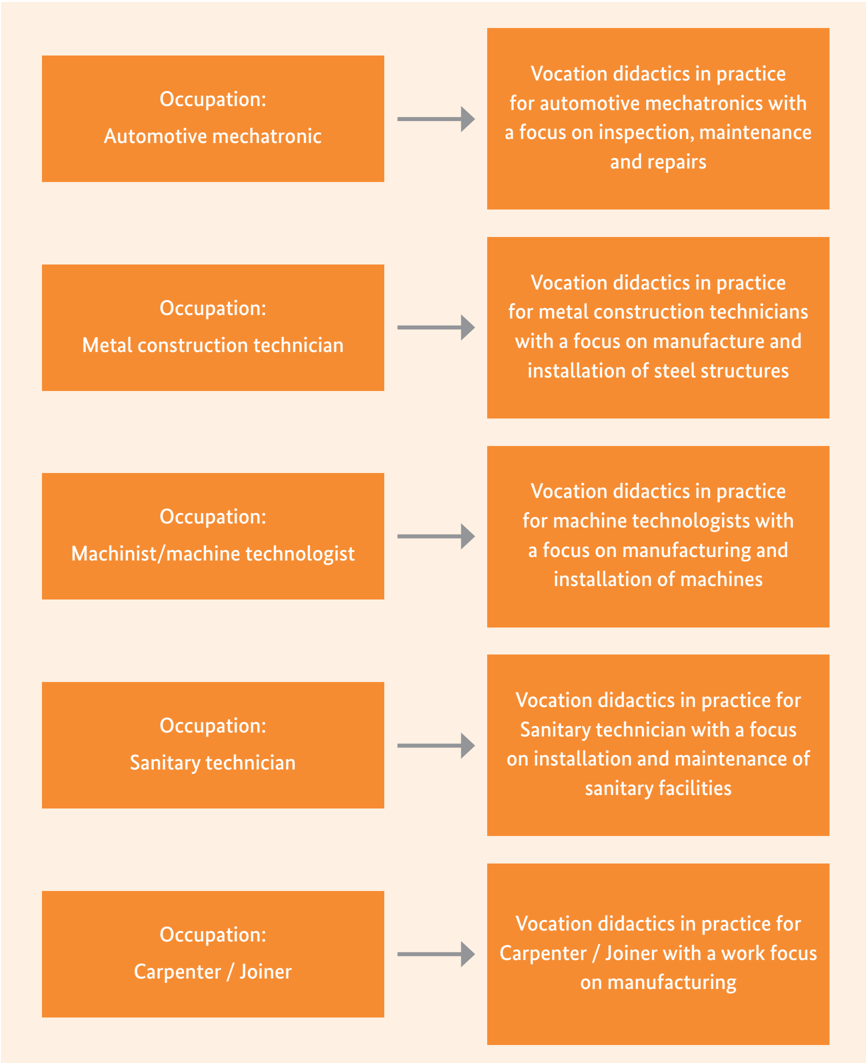


Fig. 32: The relationship between occupations and vocational didactics

Generally, for each kind of vocation didactics in the broader sense, the relationships between didactics in the narrower sense and methodology apply.

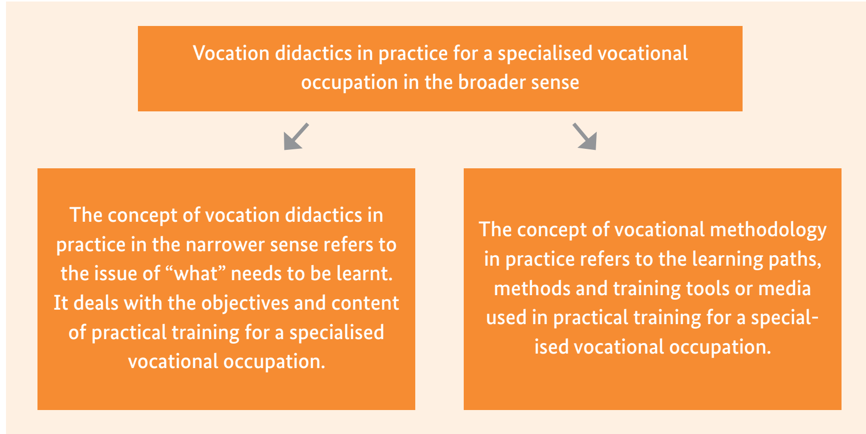


Fig. 33: The relationship between didactics in the broader sense, didactics in the narrower sense and methodology

Didactics in practice for vocational teaching and learning can be divided according to profession into many different types of vocation didactics, which are similar in their basic structures.

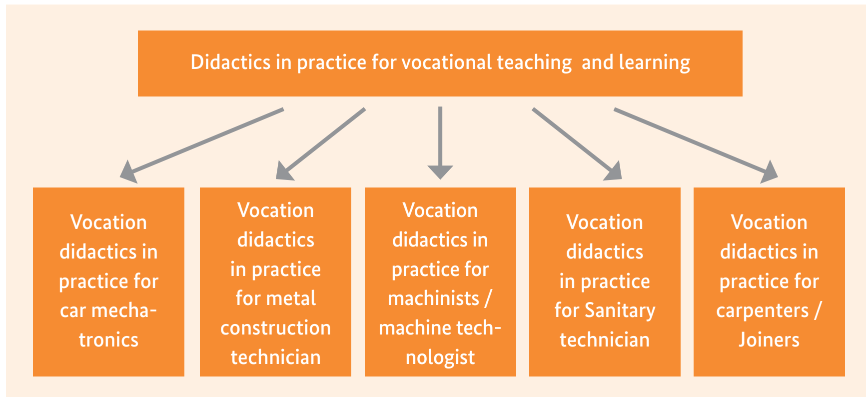


Fig. 34: Didactics in practice for vocational teaching and learning

The individual components of each of these vocation didactics are very different. For example, the vocational didactics for carpenters / joiners contains topics and learning contents that are completely different to those in the vocation didactics for sanitary facilities technicians. The same is true of the objectives as well as the work equipment and learning procedures.

2.2 Social forms and seating arrangements

Trainees and trainers have a different kind of social interaction with one another. The relationship between them becomes clear just by looking at the arrangement of the classroom during the lesson.

These arrangements – for example, division into groups – are known as social forms. At school, there are many different kinds of social forms, that is, forms of social interaction during the learning process. These are again reflected in the various seating arrangements in the classroom. The type of activity also predetermines the possibilities for trainees to engage in self-dependent working and learning. The various kinds of activities and discussions that are included here are given the term “activity forms”.

During a lecture-style lesson, the trainer performs all of the actions.

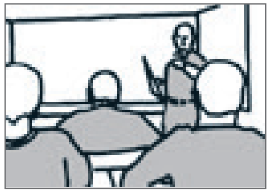


Fig. 35: Lecture-style lesson

The group lesson enables the trainees to be active.

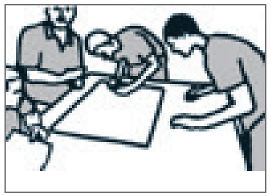


Fig. 36: Group lesson

During a lesson according to the learning field concept very different work methods and seating arrangements are used. The social forms and activity forms change constantly.

Fig. 37: Learning field lesson

Relation between activity form, social form and seating arrangements

The social forms in the classroom determine the form of activities taken by the trainer and trainees. Even in vocational teaching, lecture-style lessons are still common. This means that the trainer stands in front of the classroom next to the board. Trainees sit facing the front so that they can see the trainer. The social form is largely determined by the trainer’s initiative and actions.

Fig. 38: Organisation of the classroom during a lecture-style lesson

For the trainees, on the other hand, there are hardly any opportunities to participate actively.

As a general rule, the trainer initiates any actions in this type of lesson. The trainees have to follow the trainer’s thoughts and actions. Therefore this has been referred to as a trainer-centred style. The trainees are heteronomous.

The advantage of lecture-style lessons is that the trainer can convey the subject of the lesson to all trainees at the same time. The disadvantage is that the trainees are largely directed and have little opportunity to develop their own ideas about the topic.

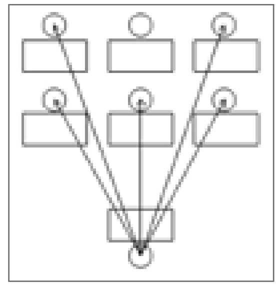


Fig. 39: Trainer’s impact on the trainees

A seating arrangement in a U-shape represents a more relaxed style. It is preferable for discussion sessions.

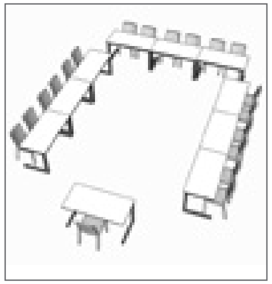


Fig. 40: More relaxed lesson in a U-shape

In this type of arrangement, the trainees are not exclusively oriented towards the trainer. They can also communicate with one another and participate in the lesson more actively. This seating arrangement is an expression of a social setting that provides opportunities for trainees to act self-dependent.

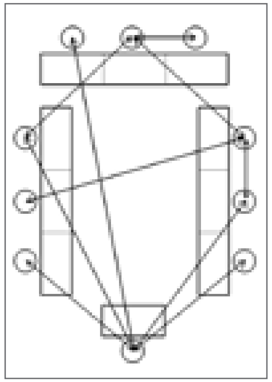


Fig. 41: Direction of communication during a lesson with U-shaped seating

The seating arrangement for a group lesson gives trainees an even greater opportunity to engage in self activity. Trainees are mostly oriented towards the other members of the group.

This kind of lesson is one example of student-centred learning. The seating arrangement for this social setting is the small group.

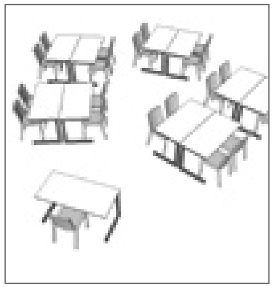


Fig. 42: Seating arrangements for group lesson

The seating arrangement for a group lesson enables trainees to develop their own solutions to given tasks. They are able to exchange ideas with one another. This contributes to their self-reliance, as they are no longer so dependent on the trainer's guidance.

In addition, this arrangement provides trainees with the opportunity to cooperate while learning. They learn to discuss practical problems with others and to develop their own ideas in order to complete tasks and problems.

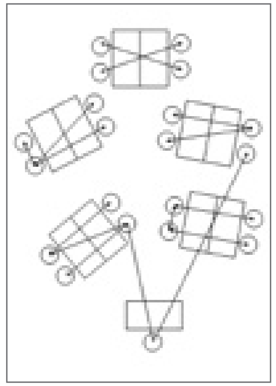


Fig. 43: Interactions during a group lesson

The classroom setup for learning field lessons is also suitable for practical working. This combination of groupwork seating and front-facing seating facilitates instruction by the trainer as well as independent learning and working.

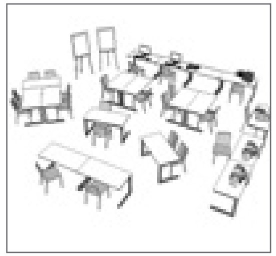


Fig. 44: Learning field classroom with varying seating arrangements

The activity forms and social forms in a learning field classroom can be changed according to the method used and type of work to be performed. There are work areas with seating arrangements that allow for lecture-style instruction. At the same time, there are other areas where trainees are encouraged to participate in group work or practical work. The type of interaction between the trainer and the trainees or the interaction between trainees in a group depends on the available learning and working opportunities.

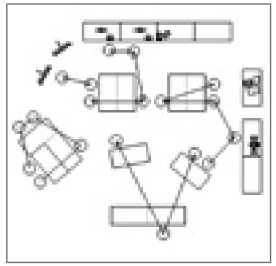


Fig. 45: Interaction during a learning field lesson

Therefore, during group work, the main interaction is amongst the trainees.

However, if it is necessary to convey information to all trainees, the trainer should give a short lecture. In this case, trainees only listen.

Classrooms that are suitable for practical learning are rooms that allow for various types of interaction. In such classrooms for practical lessons, all kinds of activity forms and social forms can be used. Different types and variations of seating arrangements serve to improve vocational teaching and learning. They also provide a means of changing the lesson structure from trainer-centred to student-centred.

2.3 Self-dependence and self-direction for vocational learning

For self-directed learning, the three stages of planning, implementation and controlling should be observed.

Trainees should be encouraged to engage in self-dependent planning, implementation and controlling. This makes it easier for them to internalise learnt sustainable and become professionals.

Self-directed learning and working encourages trainees to observe, use and manipulate vocational information from a variety of sources such as textbooks, verbal instruction, observation of work processes and integration of previous experience.

This enables trainees to practice self-dependent planning, implementation and controlling of work orders.

Fig. 46: A trainee notes a work process and collects information

The first step in a work assignment is to perform work planning. Trainees identify the specific requirements for the work order by discussing these with the trainer and take planning steps.

Fig. 47: Trainer and trainee discuss the next work tasks

The trainer demonstrates the planning process on the computer screen. The trainees listen attentively. He considers the guidelines and notes down the work steps on paper. The trainer checks the trainees' planning progress.

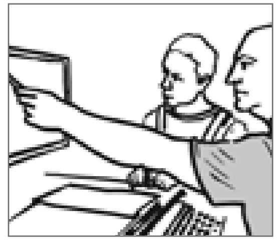


Fig. 48: Trainer and trainee working at the workbench with a computer for work planning

After planning the work order, the trainees take the first work step in the planned procedure, following the trainer's instruction. During the implementation, the trainees try to complete the work step of "grinding" in a professional manner, to their own and the trainer's satisfaction.

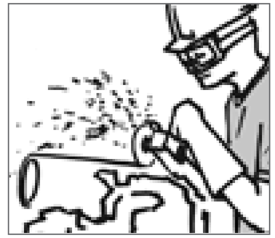


Fig. 49: A trainee performing grinding work self-dependently

Once they have completed the grinding, the trainees perform the next work step according to their plans, which is drilling the workpiece. Self-directed tasks like this motivate the trainees to carry out tasks such as drilling in a professional manner and allow them to expand their knowledge in this area.

Fig. 50: A trainee working self-dependently

Once all the planned steps have been performed, the implementation stage is complete. Next, the finished work is checked. To do so, the learner check their own work first. If necessary, an additional check can be also made by the technical teacher or instructor.

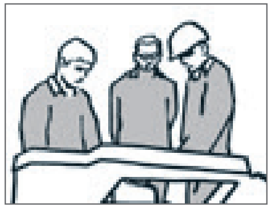


Fig. 51: Work inspection by trainees and then by the trainer

If trainees plan, implement and control by themselves, learning and working processes can become particularly motivating for them.

Therefore, self-directed learning helps trainees acquire technical knowledge and skills. The aim is for trainees to identify and develop their own learning opportunities and interests, and to find their "own path" in vocational learning.

The principle of self-directed working and learning is that for the most part, the trainees plan, implement and control their own activities.

They decide which learning opportunities are appropriate for the learning process based on their knowledge and conviction.

2.4 Selection of methods and processes

If the method is to be considered as the path towards a goal, as a trainer you will need to ask yourself before the lesson: which path, in other words which method, should I choose? The following criteria will help to answer this question:

a) **Does the method closely relate to the content? (Suitability of method for content)**

The trainees' understanding of the learning content must be facilitated by the selected method. Specific content requires equally specific methods. Accordingly, the selected method must be adapted considerably in order to fit the content. For this reason, the trainer should select the method that particularly suits that specific area of the content.

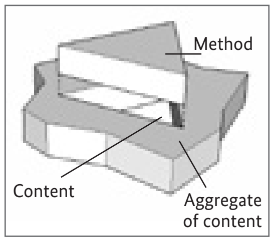


Fig. 52: Content and methods correspond structurally

b) **Does the method have the desired effect on the trainees? (Coherence between method and intentions)**

The trainees' style of working and learning is determined by the selected methods. Work methods can also be closely related to learning methods.

For example, the work method used for manufacturing is related to the manufacturing method. The style of the selected method must correspond to the practical intentions.

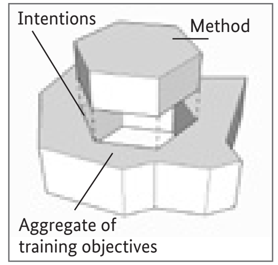


Fig. 53: Method and its relation to intentions

c) **Are the trainees capable of using the method? (Accessibility)**

In order to make use of a method properly, trainees need to have specific abilities. This is an important prerequisite for being able to work and learn according to the method and to achieve the desired learning results.

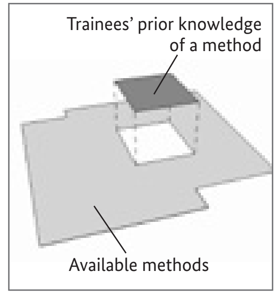


Fig. 54: Accessibility of methods

d) **Is the method based on processes and experience? (Process orientation)**

Can this method be used to convey specific action sequences that belong to the higher ranking work processes? Are trainees able to acquire experience of their own through this method?

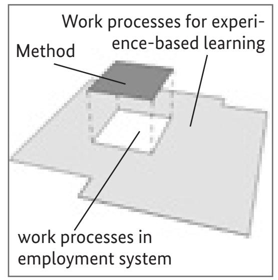


Fig. 55: Relation of process and experience to method

e) Can the method be realised in (learning) arrangement? (Arrangeability)

In order to implement a method successfully, the appropriate educational prerequisites must be available. Depending on the method, these might include special classrooms, materials, machines, tools or other appliances. Also, the time factor always has to be kept in mind.

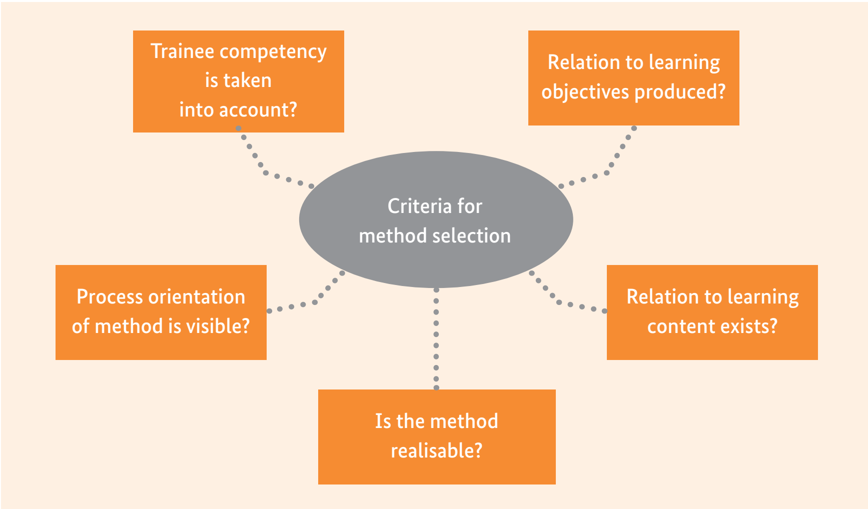


Fig. 56: Various factors that affect the selection of a method

If there is a particular method that is being considered for a specific training procedure, it can be reviewed according to a checklist (Fig. 57).

Issues to check / Evaluation		Yes	No	It depends
a.	Suitability of the method for the content			
b.	Coherence between the method and objectives			
c.	Methodological competencies of trainer and trainees			
d.	Process orientation of the method			
e.	Realisability of the method			
Overall evaluation/Improvements:				

Fig. 57: Checklist for evaluation of a method for practical application (selection)

2. 5 Exercises and questions for review and consolidation

1. Which areas are included in didactics in the broader sense?
2. Please name the issues covered by didactics in the narrower sense.
3. What is the main focus when considering methods?
4. What is the term for didactics that are oriented towards a profession?
5. Please name examples of vocation didactics in practice.
6. What is understood by the concept “social forms”?
7. Which activities are included in activity forms?
8. Please name some typical activity forms and social forms.
9. What are the characteristic features of lecture-style lessons?
10. For what kind of teaching format is a U-shaped seating arrangement recommended?
11. Which social activities take place during a group lesson?
12. Please draw a diagram of interaction when there is a U-shaped seating arrangement.
13. Which social forms promote a lesson that is learner-centred?
14. What is the basis of trainees’ entitlement to self-dependence?
15. Describe the requirements for self-directed learning and working.
16. Which competencies can be developed through self-directed learning?
17. From which perspectives should the selection of methods and processes be made?
18. What is the relationship between the method and the content?
19. How are methods and objectives related with each other?
20. What factor determines the method that the trainer should select for the trainees?
21. Which factors are important for selecting of methods?

3. Methods of practical training

3.1 Company-based apprenticeship training

3.1.1 Basic principles

Company-based apprenticeship training has a long tradition as an important form of in-company instruction.

Apprenticeship training means that the apprentice is "put next to" a journeyman or a master craftsman. At first, the apprentice just observes the worksteps.

This does not mean that the trainee simply watches. Observation alone is not enough. The trainee has to think actively.

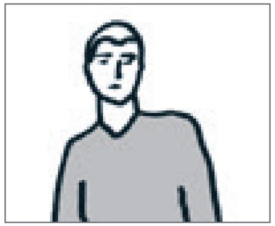


Fig. 58: Just watching is not good enough

The trainees are motivated to observe carefully due to their awareness of the work situation and their own activities ahead. The trainees start out by gaining experience that is almost all observation-based. This means that neither the product, nor the equipment, nor the trainees are in any danger. At the same time, the trainees' capacity for perception and concentration increase. Besides observing, the apprentice should also lend a helping hand, such as in the case of the carpenter´s workshop pictured.

Fig. 59: Apprentice helping a journeyman

In addition, the apprentice can always ask questions or ask to have something demonstrated – for example the measurement procedure. After that, he or she will be able to perform this procedure alone.

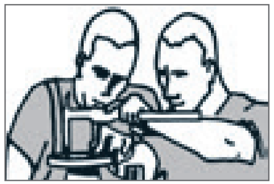


Fig. 60: Trainer instructing the apprentice

The disadvantages of this method are that close, detailed guidance is necessary for the learning process and that trainees have a very low degree of independence at first. However, manual skills cannot effectively be conveyed through media such as speech and writing. On the contrary, they require a concept that encourages the trainee to participate, to "copy" and to imitate, which should be directly verifiable.

Over the course of time, the professional and the apprentice work together more and more effectively.

One example of this is forging by hand:
The jouneyman is hammering the forging with a small hammer to show where the heavy hammer should hit hard. This procedure is manageable for the apprentice. At first the apprentice watches as the master craftsman works together with another apprentice to carry out the activity, which the master craftsman has already in key words outlined in advance.

Fig. 61: Apprenticeship training: Apprentice and master craftsman forging a forging

After giving another brief explanation, the master craftsman performs the task together with the apprentice. Once they have repeated the procedure several times, they might even swap positions.

The company-based apprenticeship training is a simple form of training. This is directed to the imitation of vocational activities. According to this process, over time the apprentice should develop vocational competencies through working and learning. This informal type of vocational training is a means of practice by imitating divided working steps.

Due to the experience that they acquire during the apprenticeship training, apprentices learn to approach an activity with caution. They understand the work as a sequence of working steps up to simple movement of the hand. The apprentices learn to think in an anticipatory way.

Stage 1:
Observation of work steps and techniques

Stage 2:
Helping hand and provision of simple assistance

Stage 3:
Instruction by the journeyman or master craftsman

Stage 4:
Practising simple tasks in small steps

Stage 5:
Execution of simple detailed work and work tasks

Stage 6:
Cooperation with journeyman or master craftsman

Stage 7:
Self-dependent execution of a work order

Fig. 62: Steps involved in company-based apprenticeship training

Assessment criteria	Company-based apprenticeship training
Characteristics	Apprentices participate increasingly in work activities, going from "observing" to "self-dependent activity". Apprenticeship training is based on learning by imitation. Through the repetition of small steps and instruction trainees acquire vocational competencies and skills.
Learning objectives	The trainees are able to ... - observe and understand work activities and technical working equipment in a work context - imitate work activities and bring them by themselves to perfection - accept direct criticism of their own work actions - increase their capacity for perception and concentration.
Procedure	a. observation of work steps and techniques b. helping hand and provision of simple assistance c. instruction by the journeyman or master craftsman d. practising simple tasks in small steps e. execution of simple detailed work and work tasks f. cooperation with journeyman or master craftsman g. self-dependent execution of work orders

Fig. 63: Company-based apprenticeship training – an overview

3.1.2 Sample lesson: apprenticeship training in the vocational field of "joinery and carpentry"

The course module is directed on wood working with machines. The operation of woodworking machines is an important topic in the vocational field joinery and carpentry and for the professional practice of the woodworking mechanic.

There is a very large potential safety hazard when working with a sliding table saw. The subject of the course module is the cutting of innovative wood materials according to professional standards. This means that some aspects of work safety will have to be taken into account. The learning process is divided into seven stages.

1st stage: observation of work activities and techniques

In order to cut the wood materials, the master craftsman changes the saw blade. First, he cuts separate wood materials using the sliding table saw. The apprentice observes these procedures.

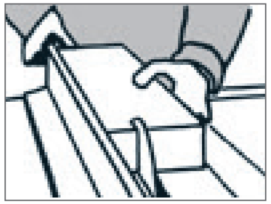


Fig. 64: Apprenticeship Training at a sliding table saw

2nd stage: helping hand and provision of simple assistance

The apprentice passes the material to the master craftsman. Once the master craftsman has cut the wood material, the apprentice takes the material processed and stores it.

3rd stage: instruction by the trainer

The master craftsman instructs the apprentice how to set up and operate the machine.

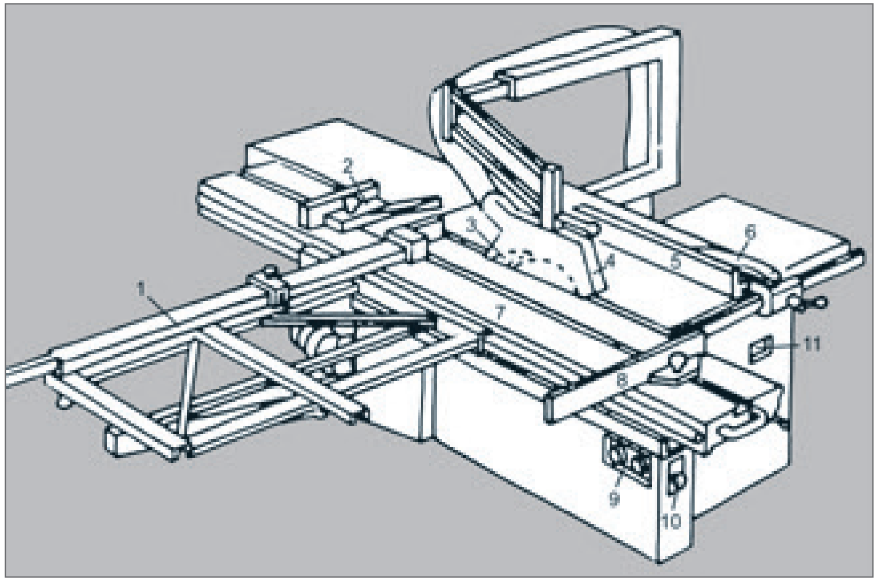


Fig. 65: Parts of a sliding table saw: 1. Crosscut fence, 2. Clamping shoe, 3. Splitting wedge, 4. Safety hood, 5. Rip fence, 6. Push stick, 7. Saw carriage, 8. Crosscut mitre fence, 9. On-off, 10. Emergency stop switch, 11. RPM display

4th stage: practice of work tasks in small steps

The apprentice performs several simple tasks using the sliding table saw. The master craftsman checks carefully and gives advice for improved handling or manual operations. The apprentice is praised for successfully completing the tasks using the sliding table saw.

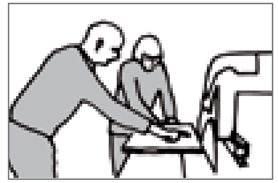


Fig. 66: Master craftsman providing advice

5th stage: execution of simple detailed work and work tasks

The apprentice performs simple detailed work and tasks using the sliding table saw. This might be cutting the parts for a simple product such as a cupboard, or a small series such as shelves.

6th stage: cooperation with journeyman or master craftsman

The apprentice also assists the master craftsmantrainer or journeman with some of the steps in the work process. In doing so, he can receive additional advice for the procedure and manual operations.

The master craftsman and apprentice now change roles for processing the material. At the same time, the complexity also increases – for example by switching roles when taking measurements of the material.

Fig. 67: Cooperative work using the circular saw

7th stage: self-dependent execution of a work order

When the apprentice has spent some time working together with others, the master craftsman judges that the apprentice is now capable of performing basic important tasks using the sliding table saw. The apprentice can now be given work orders with an easy to medium degree of complexity to carry out self-dependently.

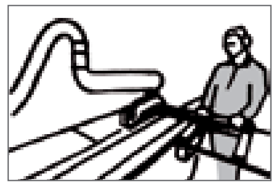


Fig. 68: Self-dependent work

For an apprenticeship in using the sliding table saw, several hours or even days should be allowed, depending on the number of apprenticies. For safety reasons it is also important for the trainer to remain present during this time.

The stage of self-dependent working should be concluded with a learning progress test. The apprentice could be asked to cut the parts for a small project. The master craftsman can evaluate the professional implementation of cutting techniques. Also, the finished products themselves can be evaluated, for example by checking the accuracy of the dimensions or the amount of offcuts.

As a means of introducing young people to woodworking using machines, the apprenticeship plays an important role. However, the introduction to processing wood materials using the sliding table saw is only example of the many possible applications of an apprenticeship. The main intentions and the structure set out in this example can be applied to similar cases in this profession and to other professions as well.

3.2 Four-step method

3.2.1 Basic principles

The four-step method, as the name suggests, is characterised by a sequence of four stages, which are:

- Preparation
- Demonstration
- Imitation
- Self-dependent application

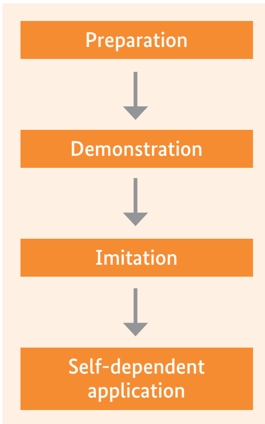


Fig. 69: Sequence of steps in the four-step method

The aim of the first stage is to serve as preparation for practical learning – such as the example given here from electrical technology. This involves taking the apprentices' existing knowledge into account. The exercise should be introduced and made clear. The apprentice should feel less inhibited by the end of this stage. This stage also applies to other kinds of methodological interactions, but this does not make it any less important.

Fig. 70: Preparatory discussion

The second stage of demonstration and explanation by the master craftsman allows apprentices to become familiar with the practical work. They come to understand why the work needs to be performed in the demonstrated manner. At the conclusion of this demonstration stage, the trainees should be so comfortable with the work that they feel confident enough to accomplish it self-dependently.

Fig. 71: Demonstration by the master craftsman

In the third stage, it is the apprentices' turn to engage actively. For the profession of metalworker, for example, the apprentices are first encouraged to try performing the work. Then they complete the task, explain it and give reasons for their actions. After finishing several exercises the apprentices should be in a position to name the learning and working processes, and describe and explain the necessary skills.

Fig. 72: Apprenticess practising the work process

The fourth step, the conclusion of the instruction process, allows the apprentices to practise and improve their competence. The master craftsman provides guidance at this stage by encouraging apprentices to ask questions and giving them positive feedback for their efforts.

Fig. 73: Self-dependent application

General procedure		Notes
Stage 1 Prepare the apprentices	1. Reduce self-consciousness 2. Explain work task 3. Name learning objectives 4. Check prior knowledge 5. Awaken interest 6. Set up apprentices properly	Required equipment and work pieces must be ready Instructions must be up-to-date
Stage 2 Demonstrate the work task for the apprentices	1. Demonstration method: Demonstrate task and explain WHAT is happening – provide overview	Repeat demonstration if necessary Demonstrate in steps Watch the learner Give the learner an activity as soon as possible; pay attention to type of work task Make it easy for the learner to remember the information
	2. Demonstration method: Explain precisely and give reasons: WHAT, HOW and WHY particularly	
	3. Demonstration method: Demonstrate quickly and emphasise points to note in learning sequences and work processes	
Stage 3 Allow apprentices to imitate the work task	1. Implementation method: Let apprentices try – allow repeat of communication. Only correct serious errors.	If necessary, allow them to repeat the task serval times Ask questions, encourage learners to ask questions Only let learners practise self-dependently after they have completed the work task
	2. Implementation method: Let apprentices carry out task and repeat of communication: WHAT, HOW and WHY particularly	
	3. Implementation method: Allow apprentices to imitate at greater speed and communicate short text (learning sequences and work processes)	
Stage 4 Conclude the instruction	1. Let trainees practise self-dependently 2. Designate a helper 3. Check and assist more frequently to begin with 4. Acknowledge and correct	Observe regularities for practice – avoid mass practice Ensure understanding of contexts Monitor learning progress and allow trainees to see it

Fig. 74: The four-step method of work instruction[2]

2 REFA: Methodenlehre des Arbeitsstudiums, Teil 6, Arbeitsunterweisung München 1975, S. 111

3.2.2 Sample lesson: four-step method in the subject of "automotive technology"

The course module is aimed at teaching the professional way to change car tyres of a motor vehicle. Accurate assembly is an important issue in the vocational field of "automotive technology" and an essential skill in practice as a car mechanic. It can be assumed that the apprentices have already observed the tyre changing process. Therefore it can also be assumed that apprentices have previous knowledge.

This apparently simple exercise actually involves a great deal of responsibility. The subject of the course module is professional changing a car tyre with assessment of the tyre followed by wheel balancing. This means that aspects of traffic security need to be taken into account. The learning process is divided into four main stages. Each main stage can be broken down further into steps.

Stage 1 - Preparation

Step 1: Task formulation

In the first stage, the work task can be introduced immediately and the most important practical actions can be determined. Because this is an apparently simple activity the apprentices feel motivated to start working at once.

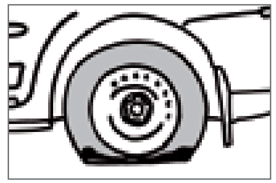


Fig. 75: Tyre failure

Step 2:

If the trainees already have prior knowledge, a discussion of the necessary tools or work sequence can be useful.

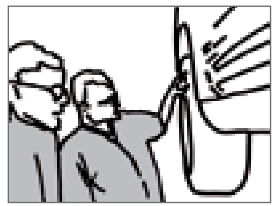


Fig.76: Master craftsman and apprentice discussing the task

Stage 2 - Demonstration

Step 1: Disassembly

The parking brake is engaged. The master craftsman demonstrates how to dismantle the hubcap using a screwdriver.

The apprentices are shown a special type of wrench for loosening the wheel nuts. Next, the master craftsman loosens the wheel nuts a little.

Fig. 77: Loosening the wheel nuts

However, the wheel nuts are not completely unscrewed. First, a jack is used to lift up the vehicle. Then the wheel nuts are taken out and the wheel is taken off.

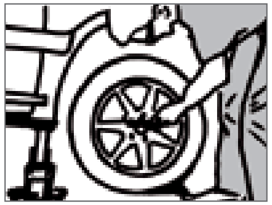


Fig.78: Taking out the wheel nuts

Step 2:

The damaged tyre and the wheel are examined.

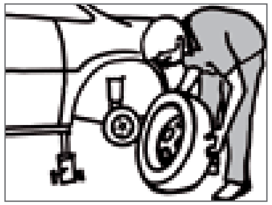


Fig. 79: Examining the tyre and the condition of the wheel

A tyre changer machine is used to take the old tyre off the wheel. A new tyre is selected by comparing the figures printed on the surface. The wheel is examined for damage and the sealing is inspected carefully and cleaned. The rubber valve is also inspected.

Fig. 80: Tyre and wheel

The new tyre or repaired tyre is mounted to the wheel. The tyre is filled with compressed air and the air pressure is checked.

Step 3:

The tyre is taken to the balancing machine. Safety procedures must be observed during this process.

After performing a test run with the machine, the balancing weights are mounted. A second check of the tyre is performed in a balanced state.

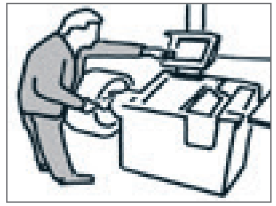


Fig. 81: Balancing the tyre with the machine

Step 4:

The wheel with the new tyre attached is taken off the balancing machine, inspected and rolled to the motor vehicle.

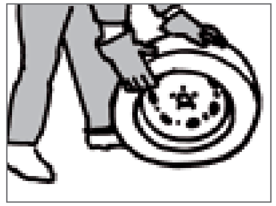


Fig.82: The wheel with the new tyre on the way from the balancing machine to the car

Step 5:

The wheel is positioned and the wheel nuts are attached loosely. The jack is lowered and removed. With a torque wrench or a portable machine, two opposing wheel nuts are always attached one after another.

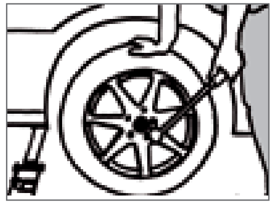


Fig. 83: Working with the torque wrench

Finally the alignment of the wheel is checked and the tyre pressure is measured on all of the tyres.

The vehicle is taken for a test drive. The apprentices recognise that their prior knowledge can still be added to.

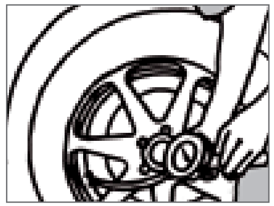


Fig. 84: Testing the air pressure

Stage 3 - Imitation

Step 1:

Next, apprentices try their own hand at changing a tyre. The master craftsman or journeyman observes each work step. If necessary, the master craftsman or journeyman corrects the apprentice's technique. When apprentices are ready to work with the balancing machine, the master craftsman starts monitoring them before the machine is switched on.

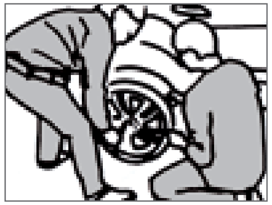


Fig. 85: Master craftsman corrects during practice

Step 2:

After the first work test, apprentices repeat the individual steps involved in changing a tyre several times, and also describe and explain the work process.

Fig. 86: Apprentices practice each work step

Apprentices attach the wheel nuts in a crosswise fashion using the torque wrench. Then they practise loosening the wheel nuts with a wheel lug wrench.

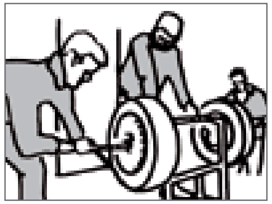


Fig. 87: Apprentices change the tyre and explain (here, at a learning station)

Stage 4. Self-dependent application

Step 1:

The master craftsman gives the apprentices the freedom to practise and improve their skills in changing a tyre. During this time, the master craftsman stays in the background and only helps when there is a problem. The master craftsman praises the apprentices for their efforts.

Fig. 88: Changing a wheel self-dependently

Step 2:

The master craftsman finishes the instruction with a final conversation. The overall work sequence and work process are reviewed. Then, the master craftsman refers to the apparently simple task of changing a tyre to point out to the apprentices that it is always possible to expand their previous knowledge about a work process. Also, they discuss what aspects of their knowledge about changing a tyre can be applied to other topics in automotive technology.

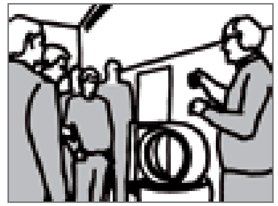


Fig. 89: Concluding discussion with master craftsman

3.3 Practical short lecture

3.3.1 Basic principles

A lecture is a means of communicating complex information on a technical subject in verbal form. It serves primarily to convey information presented in a structured and condensed way.

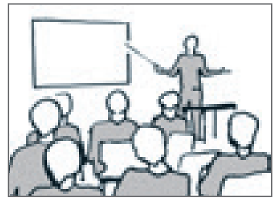


Fig. 90: Practical short lecture

Lectures can provide an overview of a topic and in a relatively short time present contexts, problems and issues systematically and concentratedly. They can introduce new material and provide general orientation. Moreover, good lectures can contribute to the development of listeners' interest.

Lectures are unavoidable in professional learning. However, they must be incorporated into the teaching-learning process in a thoughtful and meaningful manner. The lecturer should make use of media to aid understanding. Besides the blackboard, media can include drawings, models and materials, as well as tools or machines.

A distinction is made between a teacher lecture and a learner lecture.

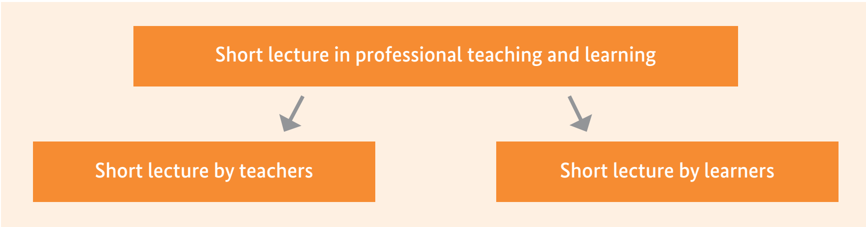


Fig. 91: Difference between lecture by teacher and lecture by learner

Lectures by the teacher are the more common form. Learners hold usually only short lectures in special cases.

Teacher lecture

For the teacher lecture the trainer stands in front of the group of learners and presents a practical subject-specific topic. The lecture should be kept as short as possible, as apprentices generally have limited capacity to concentrate on spoken information. Based on their experience, trainers know that trainees don't remember much of the lecture.

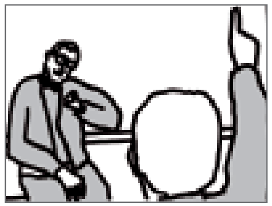


Fig. 92: Teacher answers questions during a lecture

The sequence of information in the presentation should be well-structured and identifiable. The trainer should decide on the sequence and which information to include depending on the matter and the learnability.

Lectures are more effective when the subject is presented in a clearly arranged structure. Also, limit the number of new terms or pieces of information to a maximum of seven.

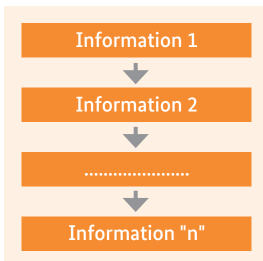


Fig. 93: Sequence of information or terms in a lecture

When giving a short lecture for a practical instruction, the trainer should use media, equipment and devices to make the information easier to understand.

The lecture should not stand alone in the lesson. The learners need to know what meaning the lecture has for them and how it relates to the other contents of the learning process.

Fig. 94: Teacher showing apprentices a machine for clarification during a lecture

It should be incorporated into the course in stages, allowing for trainees to participate actively and to build on the knowledge that they obtained from the lecture.

Learner lecture

The requirements for a learner lecture are similar to those for a teacher lecture. The difference between them is that in this case learners themselves prepare a lecture on selected aspects of the topic and present it. During the lecture, they take on the role of teacher. The advantages of this are that learners

- learn to investigate a topic self-dependently
- develop the abilities to communicate verbally and present their opinions to others
- internalise the course content better than by listening alone.

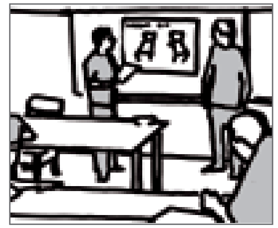


Fig. 95: Lecture by learners

The type and format of the lecture depends on the content, the learners' level of knowledge and most importantly, the purpose.

Procedure for a practical short lecture

Practical short lectures can be divided into three stages:

The main purpose of the **introduction** is to

- awaken the interest of the listeners and
- outline the most important points to be covered in the lecture.

During the **main body** of a short lecture, the lecturer should aim to

- present a logical, structured format in a way that is easy to understand
- engage the interest of the audience (for example through the use of media)
- provide clear and easily comprehensible information – for example by including examples as illustration and avoiding ambiguous expressions
- limit the amount of information.

The aim of the **conclusion** is to

- summarise the most important aspects of the lecture and
- answer any questions from the listeners.

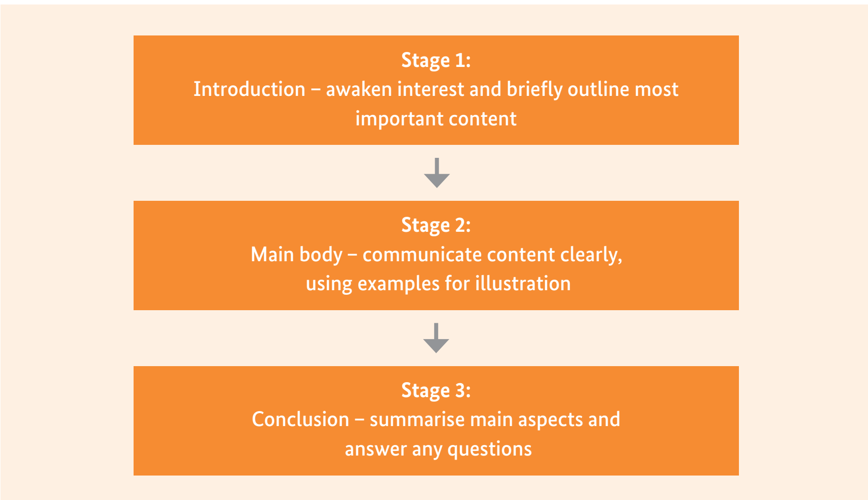


Fig. 96: Flow chart of a short lecture

Assessment criteria	Practical short lecture
Characteristics	The main purpose of a practical short lecture is to impart technical knowledge. The lecture can be used to introduce a new topic, provide an overview or review a course module once it has been completed. Media are used to make the lecture easier to understand. When learners give lectures, they acquire additional competencies.
Learning objectives	Short lectures **by the master craftsman** provide the apprentices with - an overview of information and knowledge in a subject matter - the ability to concentrate on a topic for a short duration Short lectures **by the learner** themselves give them - an overview of information and knowledge in a subject - the ability to concentrate on a subject for a short duration - the capacity to formulate a topic self-dependently - the competences of articulating and presenting content
Procedure	a. **Introduction**: awaken interest of the listeners / provide an overview of the subject of the lecture b. **Main body**: present structured content in a logical sequence / engage interest of the listeners / provide information that is easy to under-stand c. **Conclusion**: summarise the lecture and answer questions from listeners

Fig. 97: A practical short lecture – an overview

3.3.2 Sample lesson: short lecture in the vocational field of "Electrical Engineering"

Introduction:

The instructor establishes that most of the apprentices face a practical problem during work on their trial equipment, which they are unable to solve with their existing knowledge in electrical technology. The instructor asks everyone in the laboratory to gather around. Referring to the difficulties that apprentices have been experiencing, the instructor announces the subject of the lecture.

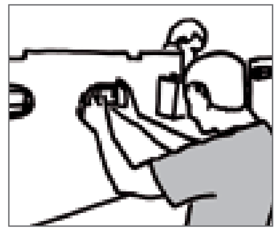


Fig. 98: Apprentices with problems statement during installation work

Main body:

Referring to a switch panel, which the trainees already have in front of them on their workstations, the trainer explains the role of the RCD safety switch (**R**esidual **C**urrent Protective **D**evice). This breaks the circuit at all poles within fractions of a second when the dangerous voltage arises. The trainer demonstrates the switch again and refers to the electrical drawing on the switch. Then, the trainer turns to a large illustration showing the function of this protective device and explains how the RCD works.

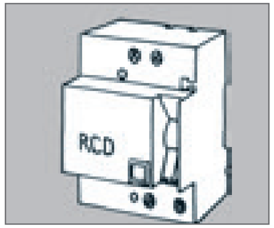


Fig. 99: RCD as medium for a short lecture

Conclusion:

The teacher summarises the most important information and refers the apprentices to its relevance for further work on their trial equipment.

The apprentices may ask the trainer questions and take notes on important points.

Fig. 100: Lecture by apprentices

3.4 Practical discussion

3.4.1 Basic principles

In a practical discussion, the apprentices take on the role of experts. A practical subject that they are very familiar with is selected for discussion. At this stage, apprentices already have practical knowledge and experience. The reason for a practical discussion is often a problem or an upcoming decision. This is what the apprentices need to discuss. During a group meeting, they form their own opinions and defend them. Finally, everyone decides on the solution to the problem together.

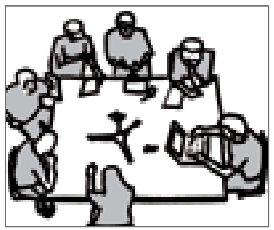


Fig. 101: Apprentices and trainer having a practical discussion

A practical discussion can be divided into four stages, with each stage building on the previous one:

Stage 1:
Introduction through an initial question or problem

↓

Stage 2:
Development of discussion with apprentices giving their opinions

↓

Stage 3:
Arrange of opinions for consideration respectiviely solutions of the problem

↓

Stage 4:
Decision-making stage to answer the initial question or solve the problem

Fig. 102: Stages in a practical discussion

By engaging in practical discussions, the apprentices are able to expand on their existing knowledge. Moreover, they also acquire new abilities. They learn how to communicate verbally, defend their own opinions, express criticism and accept criticism. They also learn that some practical problems can only be solved through discussions with others.

The content of practical discussions includes observations and experiences that apprentices have taken from their world of work and life as well as concrete tasks and problems from professional work and technology.

The trainer must have basic communication skills and knowledge in addition to proven technical expertise. Trainers need to learn to restrain themselves during discussions. Only very experienced trainers succeed in thinking ahead of the discussion, as it is very hard to predict the direction that it might take.

A practical discussion should build on the learners' experience and sufficient technical knowledge, and should serve to expand both of these. Obviously, learners will need to know how to use conversational skills for good communication.

Practical discussions have a great significance for vocational didactics because they enable technical and general objectives to be combined for professional learning.

Assessment criteria	Practical discussion
Characteristics	In this procedure, students are assigned the role of experts. They make use of their existing practical knowledge and experience. The motivation for this communication between apprentices might include a practical problem, a question that needs to be clarified or an issue on which a decision needs to be made. Practical discussions can be supported by the use of media such as tools, machines, materials, pictures, texts or models.
Learning objectives	The practical discussion enables apprentices to develop skills in - verbally stating their position on practical facts or problem - forming their own opinions on a practical issue and defending these - verbal communication in a practical context
Procedure	Four main steps can be identified in practical discussions: – *the introduction* through an initial question or problem – *the development* of the discussion, during which apprentices contribute their opinions on the facts – *the arrange* of everyone's contributions for consideration respectively solution of the problem, including a final summary – *the decision-making stage*, in which arguments are evaluated to answer the initial question or solve the problem

Fig. 103: The practical discussion – an overview

3.4.2 Sample lesson: practical discussion in the vocational field of "machine technology"

The topic is titled: "Experiences, problems and manufacturing advice when drilling large holes in metal components with a hand drill". At this stage, the apprentices have already worked with the hand drill and other types of drills.

Stage 1: Introduction

The trainer introduces the discussion by commenting that everyone in the class has tried working with the hand drill. The trainer shows the class a typical large hand drill.

Then the trainer opens up the topic for discussion by asking the apprentices to name the difficulties they experienced when drilling large holes in components made of steel or other metal materials.

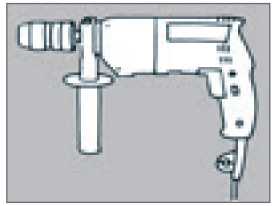


Fig. 104: Hand drill

Stage 2: Development of the discussion with input from apprentices

After hesitating at first, the learners start to speak up. They describe their experiences when drilling large holes and comment on input from fellow trainees. The trainer holds back to maintain the spontaneity of the apprentices' responses – unless their comments are off the topic.

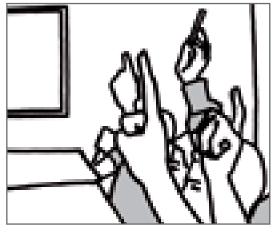


Fig. 105: Apprentices put hands up

Stage 3: Analysis of comments for consideration and solution of the problem

The trainer waits until the apprentices have provided the most important comments. Next, the trainer asks if there are any rules that can be deduced from these experiences. The trainer suggests that apprentices arrange their findings according to certain criteria. To help the apprentices get started with the systematisation process, the trainer asks them how drills are selected. The apprentices answer that the selection of the drill depends on the material and the thickness of the material. As the first problem, they suggest large-bore drilling of heavy-duty workpieces. The apprentices discuss work rules.

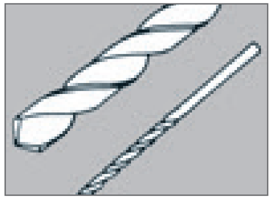


Fig. 106: Twist drill for steel

To assist the apprentices and encourage them to keep contributing their opinions, the trainer shows them three twist drills for various metal materials.

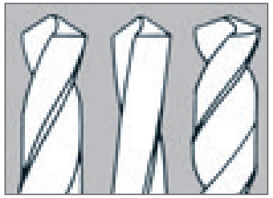


Fig. 107: Twist drill for materials

For large diameter drilling, it is important to first drill a pilot hole.

Aspects such as the size of the pilot hole to the size of cross cutting edge are important. Drills are also used with reduced cutting edge.

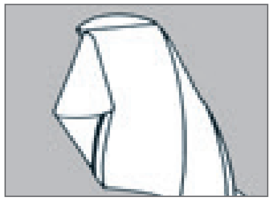


Fig. 108: Reduction of cutting edge - twist drill

As another problem for discussion, drilling of sheet metal is suggested.

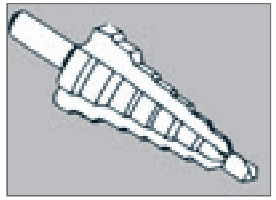


Fig. 109: Drill for sheet metal

Particular attention needs to be paid to the physical effort used when drilling and to the safety hazards involved when the drill is passing through.

To reduce the risk of accidents and to prevent deforming of the material, wood supports are used when drilling the material. The picture shows drilling without supports (above) and drilling with supports (below).

As a basic principle, all workpieces must always be clamped before processing. When drilling sheet metal, protective gloves must also be worn.

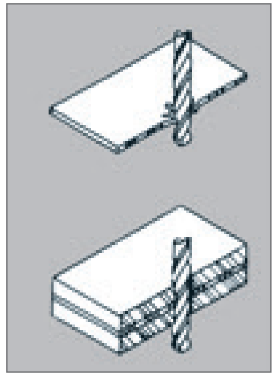


Fig. 110: Drilling without and with supports

Stage 4: Decision-making stage to answer the initial question or solve the problem

The trainer asks some of the apprentices to clarify the items that need be addressed to solve the problem and to explain their practical solution. Then, the trainer asks the apprentices to summarise their findings to create work rules. Finally, the apprentices write down these rules.

3.5 Practical demonstration

3.5.1 Basic principles

The purpose of the practical demonstration is to present facts, objects, structures or processes for technical professions by using practical media. A popular and useful application is the demonstration of tools and machines. This enables the trainer to demonstrate how a product or object is manufactured, how it functions or how it is used.

The media used in demonstrations are particularly significant. They should make complex, dynamic facts more tangible. For example, they could illustrate the interaction between various elements in structural processes, or the function of components in devices, machines and equipment.

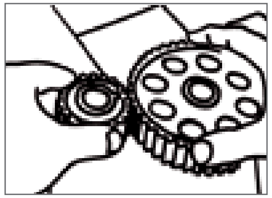


Fig. 111: Using media in a demonstration

In these cases, the listeners find it easier to understand the content when it is part of a demonstration. Observing something is more convincing and effective than just listening or reading about it, which makes the information easier to remember.

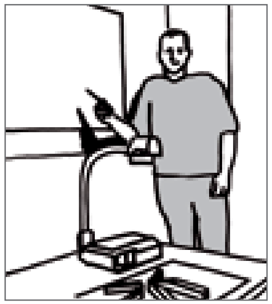


Fig. 112: Demonstration using media

The demonstration is based on the principle of learning by observing. A demonstration can leave a lasting impression on the apprentices. It helps to improve their ability to observe, concentrate on important facts and take notice of details.

Stage 1 – Introduction:
Lead-in and information about content, context and vocational significance of the subject

↓

Stage 2 – Main body:
The subject is demonstrated by means of illustrative media to make it accessible and tangible

↓

Stage 3 – Conclusion:
The information is summarised, evaluated and judged in a vocational context.

Fig. 113: Stages in a practical demonstration

For practical demonstrations, the stages need to be didactically limited. Very important are media for simulations or visualisations of real situations.

Assessment criteria	Practical demonstration
Characteristics	The practical demonstration conveys technical content and processes in the field of “work and technology”. The use of appropriate media such as graphics, text, film, models, tools or materials to illustrate complex technical information is an important component of the demonstration.
Learning objectives	Apprentices acquire knowledge and develop the ability to observe, identify and understand visualized technical information or processes (including secondary knowledge) and also optionally learn the demonstration of technical information and its reflection in vocational contexts.
Procedure	The demonstration can be roughly divided into introduction, main body and conclusion. The lesson procedure is largely dependent on the trainer’s demonstration.

Fig. 114: “Practical demonstration” – an overview

3.5.2 Sample lesson: demonstration in the vocational field of "wood technology"

Stage 1: Introduction

The mortise and tenon joint is one of the standard techniques in handicraft for connecting wood and is used for all kinds of wooden frames. The purpose of the lesson is to teach the apprentices how to make a mortise and tenon joint. The master craftsman tells the apprentices that during this simple exercise, they will be able to develop essential woodworking skills. In addition, the master craftsman also makes it clear to the apprentices that this joint creates a gluing surface that is twice as large as that of a common corner lap joint. Therefore, this type of joint is significantly more stable.

Stage 2: Main body

Step 1: First, the wood pieces that make up the frame are labelled in order to avoid any confusion later in the process.

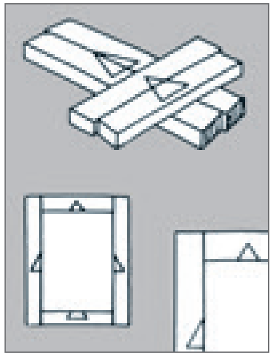


Fig. 115: Labelling the frame woods

Step 2: Using a try square and a scriber, the master craftsman marks out the wood pieces. The outer groove indicates the place for cutting the wood. The inner groove indicates the height of the frame.

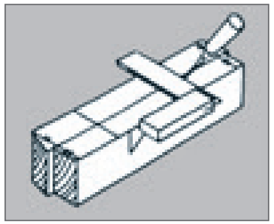


Fig. 116: Marking out the wood pieces

Step 3: Next, the dimension lines are marked onto the workpiece. The vertical mortise piece is marked with two parallel pencil lines. These lines divide the head area into three zones of equal width. The area that is going to be cut off later is marked with an x.

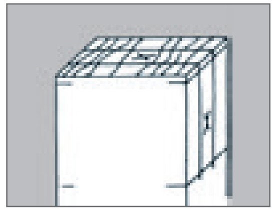


Fig. 117: Cut lines marked on the mortise piece

Step 4: The same procedure is performed on the horizontal tenon piece. Here, the two outer areas are going to be cut off later, so these are both marked with an x.

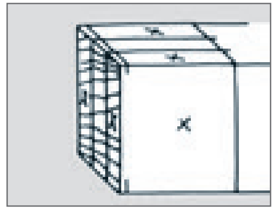


Fig. 118: Cut lines marked on the tenon piece

Step 5: The lines marked in pencil are drawn over with the scratch gauge. This makes it easier to cut the piece with a frame saw.

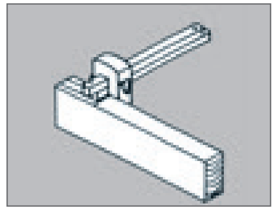


Fig. 119: Marking out with a scratch gauge

Step 6: A kerf is cut with the saw into the outer side of the marked groove, or into the “area of the workpiece to cut off”.

The side parts are removed from the workpiece – the tenon is now “free-standing”.

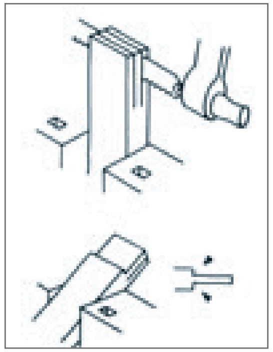


Fig. 120: Cutting out the tenon

Step 7: The mortise is chiselled out with a chisel of appropriate width. The first blows are made about two millimetres away from the marked groove and not on the groove itself. The wood at the edge of the marked groove is chiselled out carefully and neatly as a final step.

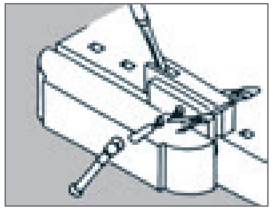


Fig. 121: Chiselling out the mortise

Step 8:
Finally, the mortise and tenon are joined together and checked. If necessary, some of the cut edges are cut down further.

Stage 3: Conclusion

To complete the practical demonstration, the master craftsman asks two apprentices to give a summary of the procedure. To do this, they use the materials and tools as media to simulate the procedure, virtually repeating it. The other apprentices observe them carefully and correct them if necessary. Finally, the apprentices summarise the main points. Also, they discuss how this knowledge might be applicable in other contexts.

3.6 Work order

3.6.1 Basic principles

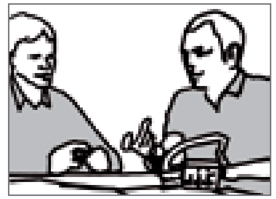


Fig.122: Meeting with customer for an order

Processing customer orders is a task that is based on the central didactic theme of the work order. The intention here is to use everyday business on the job as the material for practical learning.

Practical work order processing involves smaller tasks that can be processed and completed within a learning stage. However they are not just an incomplete part of a comprehensive work order. Only the complexity of the content is reduced, not the completeness.

In practical work order processing, aprentices learn how to independently analyse, simulate and understand the structures and specifics of work orders. Work orders can be flexibly incorporated into current lessons.

It is important to formulate work orders clearly and didactically appropriate.

When the work order is handed out, it should have an inviting and motivating effect. The prerequisite here is an obvious practical relevance. The content of the work order should appear believable. This should be achieved with support from the appropriate media.

The components of the work order are analysed. The first key work areas are determined.

Work order

Fig. 123: Work order form

Next, order planning is performed. This might involve the preparation or selection of drawings. A bar chart is drawn up for work planning.

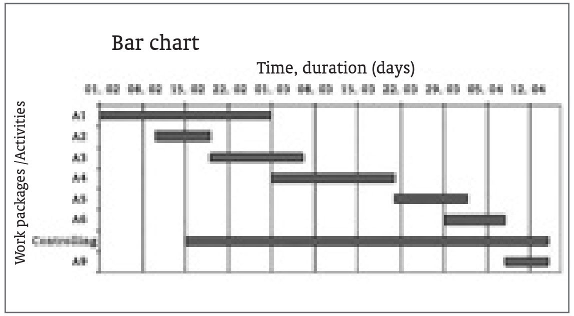


Fig.124: Structural picture for planning

Next, the work order is executed. This means that the work is prepared and performed according to the process planning. After execution, an inspection is performed.

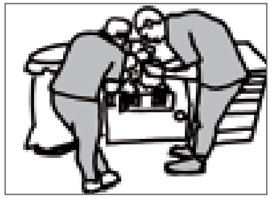


Fig. 125: Apprentices process independently a work order

Finally, apprentices work as a group to evaluate the work order.

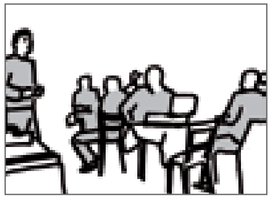


Fig. 126: Group evaluation of the work order

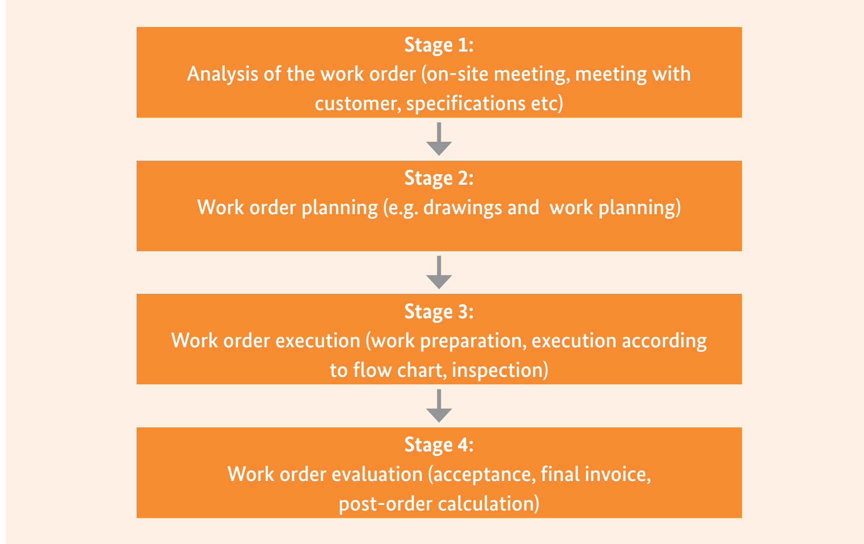


Fig. 127: Stages in order processing

For work orders, these stages need to be didactically limited. It is very important to use media to simulate or illustrate real situations. Some typical examples of work orders are replacement of a mixer tap or the connection of a washing machine.

Assessment criteria	Work order
Characteristics	Practical work order is based on customer orders encountered in business situations. Apprentices can become familiar with everyday business in their job. The work order concerns smaller assignments. It can be implemented flexibly and always involves a complete action.
Learning objectives	Apprentices acquire knowledge about - integrated work processes in companies; - the ways in which they can contribute to work processes in a business situation; - independently developing work processes within a specific framework.
Procedure	Work order processing can be divided into – work order analysis (1), – work order planning (2), – work order execution (3) and – work order evaluation (4).

Fig. 128: "Work order" – an overview

3.6.2 Sample lesson: "work order" in the vocational field of sanitary technology

Stage 1: Placing of order

An important customer wants to install a sink with hot and cold taps in their company. The materials used for the components have to be equipped for boiling water. The sink needs to be manufactured to order and must be made of corrosion-resistant, shock-resistant material.

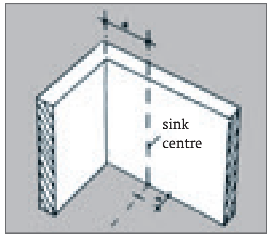


Fig. 129: Installation diagram

Splashproof measures needs to be considered for the wall. The dimensions of the sink should be 200 x 400 x 200 mm. Manually operated taps should be offered to the customer.

Original solutions for the pipe layout are to be suggested. When processing this work order, economic and aesthetic viewpoints should be considered.

Stage 2: Work order analysis

The apprentices are asked to role-play a meeting with the customer. To do so, the roles of professional and customer are assigned. The role play can take place at either company's office or on-site. The professional shows the customer the sanitary fittings, either the actual items or in a catalogue. The customer then selects the sanitary fittings.

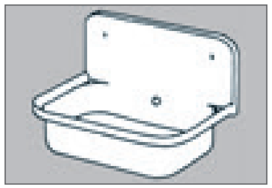


Fig. 130: The actual items can be presented in the meeting with the customer

Stage 3: Work order planning

The trainees are now given the task of work planning. This involves preparing a general arrangement drawing as a sketch. This sketch should include a parts list of all components with their numbers.

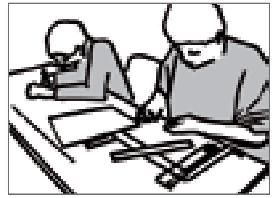


Fig. 131: Trainees draw up a plan of the structure

In addition, trainees should make a detail drawing of the installation for the calculation of dimensions (from the Y-type valve to the tap) as well as a standard parts list. They also need to prepare a work process plan for the selection of parts and installation at the customer's location.

Stage 4: Work order execution

For work preparation, the components are ordered or taken from the warehouse and delivered to the construction site so that they are ready for installation.

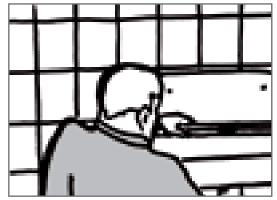


Fig. 132: Trainee installing the sink

Next, the sink is screwed in place at the specified position on the wall.

The components for the sink area are provided, checked and pre-assembled.

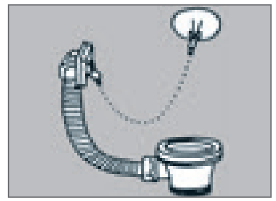


Fig.133: Pre-assembly of drain and overflow fittings

The pre-assembled components are put into position in the sink.

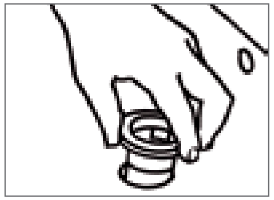


Fig. 134: Inserting pre-assembled components

The odour trap (siphon) and connecting pipes to the drain are selected and cut to size. The cut ends of the pipes are deburred.

Next, the drain pipe and the odour trap (siphon) are pre-assembled. The experimentally pre-assembled components are then installed as a connection between the sink and the drain pipe.

Fig. 135: Pre-assembly of the siphon

Once the drain has been secured, the water supply is planned in advance and the necessary components are provided.

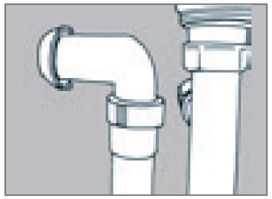


Fig. 136: Connection between sink and drain pipe

A wall bracket for the tap is selected. The tap and a pipe are provided according to the parts list.

The bracket for the tap must be centrally attached to the wall. The tap is screwed into the bracket with the addition of a sealing gasket.

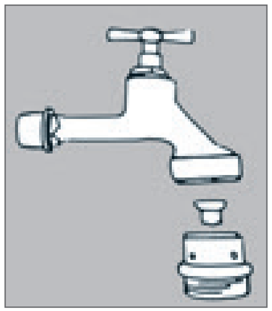


Fig. 137: Tap for the new system

Next, the pipeline between the tap and the Y-shaped valve is determined using a wire. The pipe is filled with dry sand and is bent according to the wire template.

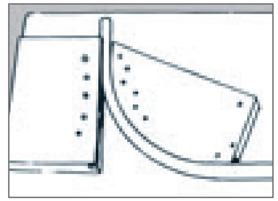


Fig. 138: Bending a pipe

The pipe is installed between the Y-shaped valve and the tap and fastened with mounting clamps.

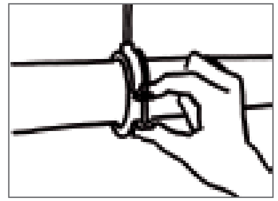


Fig. 139: Attaching the pipe with a clamp

Stage 5: Work order evaluation

First, a leak test is performed and another trainee approves this small installation. Next, the trainer examines the completed order. The trainer informs the trainees that they need to do the final accounting and post-order calculation, and then prepare the invoice for the customer.

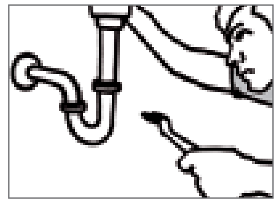


Fig. 140: A trainee performing a check

3.7 Practical experiment

3.7.1 Basic principles

Although practical experiments generally do not play much of a role in the trades in practice, they are often performed while learning, because of the many benefits that they offer. In contrast to experiments in the natural sciences, the main criterium for practical experiments is the question of usefulness. For example, a motor cannot be right or wrong; however, it can be useful or not very useful. The reason for this is that technology is a result of the implementation of practical aims.

Experiments can roughly be divided into real technology, model technology and mental experiments.

Although science experiments or experiments in scientific form do not take place in workshops or construction sites, measurements, testing and experiments im the broadest sense are carried out in practice.

For example, a woodworker measures the moisture of wood components in different locations at a construction site if there is a broken water pipe.

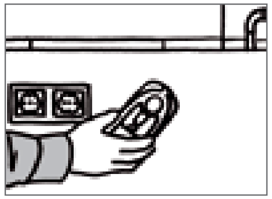


Fig. 141: Measuring wood moisture with a testing device

An electrician uses an electronic universal testing device to check the electric wiring and marks any damaged areas as necessary.

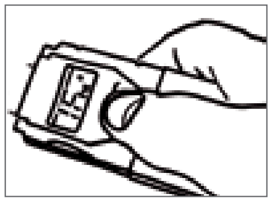


Fig. 142: Electronic multipurpose tester

A car mechanic tests the pressure change in all cylinders with a compression measurement device – after removing the spark plugs – and establishes the deviation.

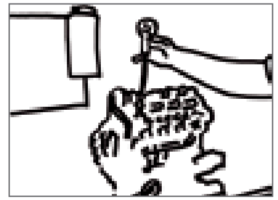


Fig. 143: Car mechanic checks pressure in cylinders

A mechanical engineer performs a filing test for the inspection of a piece of steel to determine the hardness. If the steel is soft, the file grips it; if it is hard, the file slips.

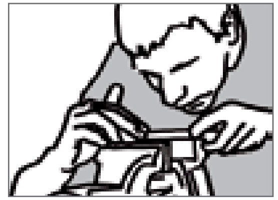


Fig. 144: Filing test in metalwork

A plumber attaches a component to a pressure pump and subjects the component to water pressure to check whether it is watertight.

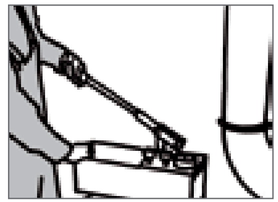


Fig. 145: Leak testing of a sanitary component

The practical experiment has a dual function: on one hand, it enables trainees to process technical information. On the other hand, it familiarises the trainees with procedures that can be used to obtain knowledge and experience that are essential for our technical and scientific working environment.

The practical experiment deals with problems that arise in practice. It could be described as the interface between technical theory and practice. It connects these two areas, which are often completely separate, and combines them into a whole.

The procedure for a practical experiment can be divided into five stages:

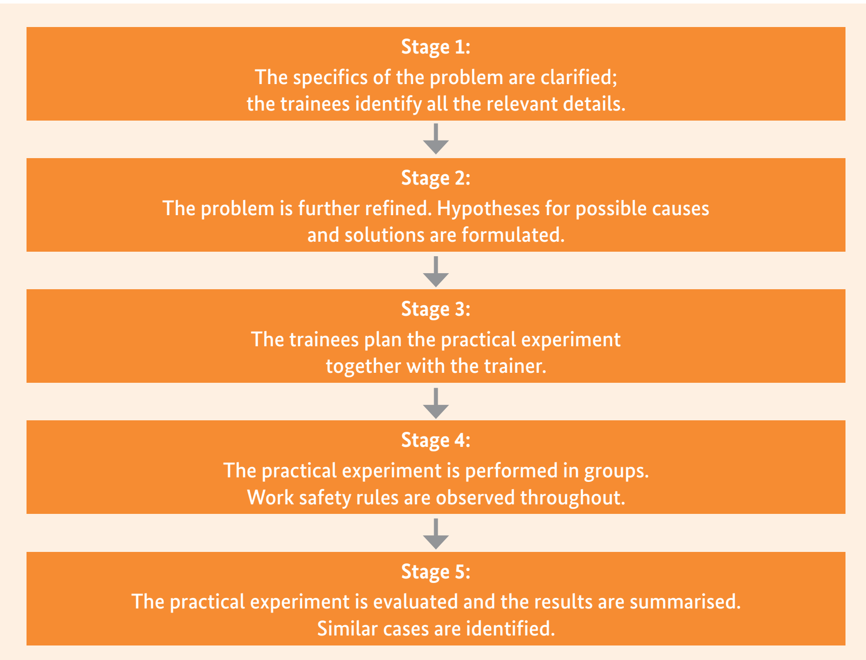


Fig. 146: Practical experiment – stages in the procedure

Assessment criteria	Practical experiment
Characteristics	A practical experiment can be used to find technical solutions or establish facts. In addition, experimental ways of gathering information can be tested during group work. In many cases, the practical experiment serves as an example. Trainees can easily apply this method to other, similar areas without much effort. It connects theory and practice.
Learning objectives	The trainees acquire the ability to ... - develop and implement strategies for collecting information - understand or identify errors, disruptions or obstacles that arise during the experiment - determine the form, the measurements and the materials for the components - develop suggestions for constructive improvements for technical systems and processes
Procedure	1) Understand the problem 2) Make the problem precise (hypothesis formulation) 3) Plan the practical experiment 4) Implement the practical experiment 5) Evaluate the experiment

Fig. 147: Practical experiment - an overview

3.7.2 Sample lesson: practical experiment in the subject of "metalwork"

The topic of this course module is: "Identification of two materials using tools and group work". The prerequisite is that trainees are familiar with the basic metalworking skills of filing, bending and grinding.

The objective of this unit is for trainees to understand important material qualities such as strength, elasticity and hardness.

Stage 1: Identification of problem

The trainer shows the trainees two pieces of drawn steel. The trainer explains that there is confusion in the steel warehouse at the moment because some of the steel was delivered to the wrong destinations. The trainer asks the trainees how these two steel rods, which got mixed up in the warehouse, can be distinguished.

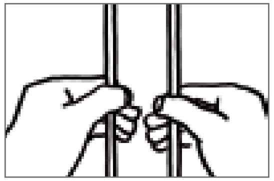


Fig. 148: The trainer shows two metal rods

Stage 2: Specification of problem (hypothesis formulation)

The trainees recognise that these two steel rods cannot be distinguished from each other by visual inspection (both are drawn steel). The trainer asks the trainees to name qualities that can be identified in steel.

During the discussion, trainees establish that the important qualities of steel are workability, hardness, tensile strength, sound and spark formation. The trainees can now make an assumption (hypothesis) that these qualities can be identified with tools in the workshop.

Stage 3: Experiment planning

The trainees discuss how an experiment should be carried out, with the help of the trainer. They come up with the answer that the experiment should be conducted as a comparison of the qualities of the two steel rods. The trainer writes the trainees' suggestions for criteria for the comparison on the board.

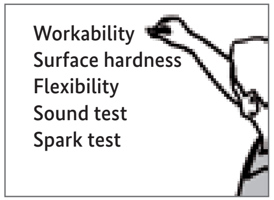


Fig. 149: Writing on the board

The trainees establish that the two samples need to be marked clearly in order to distinguish them from each other. In addition, they decide that it is useful to draw up an experiment protocol.

The following table is prepared for this purpose:

Material sample / Workshop test	Material sample 1	Material sample 2
Filing test		
Indentation test		
Sound test		
Bending test		
Spark test		

Fig. 150: Experiment protocol

The trainees are divided into work groups.
The trainer and trainees establish that they are now ready to begin the experiment.

Stage 4: Implementation of experiment

Trainees work together in groups of four. The trainees are given the tools and the material samples.

1) The first trainee performs the filing test. The trainee finds out that Material Sample 1 can be filed easily, whereas the file slips off Material Sample 2.

The other trainees in the group enter the results of the test into the experiment protocol sheet.

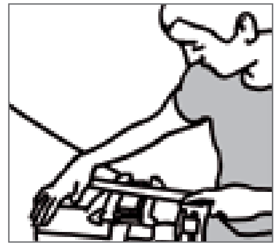


Fig. 151: Trainee with file and workpiece

2) The second trainee performs the indentation test. The trainee finds out that the tip of the punch makes a slight indentation in the surface of Material Sample 1. This is not the case with Material Sample 2.

The other trainees in the group record the results of the indentation test in the experiment protocol sheet.

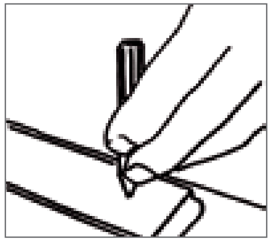


Fig. 152: Trainee with punch and material

3) Sound test

The third trainee performs the sound test. The samples are suspended and struck with a hammer. All trainees can hear a deeper sound from Material Sample 1 and a higher-pitched sound from Material Sample 2.

The trainees record the results of the sound test in their experiment protocol.

Fig. 153: Sound test

4) Bending test

The fourth trainee performs the bending test. The samples are fastened with the bench vice and bent backwards and forwards repeatedly. The trainees find out that Material Sample 1 can be bent backwards and forwards multiple times, whereas Material Sample 2 hardly bends at all and breaks when greater force is applied.

All trainees record their observations in the experiment protocol sheet.

Fig.154: Bending test on the metal workpiece

5) Spark test

All trainees gather around the grinding machine. They are each given a pair of protective glasses and a hand-out showing illustrations of sparks. The trainer explains that he or she is going to grind the material samples. The trainees are given the task of comparing the resulting sparks with the illustrations on their handouts.

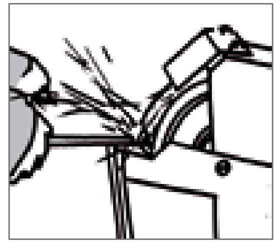


Fig. 155: Sparks given off by a workpiece

The trainees record their observations in the experiment protocol sheet.

Finally the trainees compare their observations with the entire class and correct them if necessary.

Material sample / Workshop test	Material sample 1	Material sample 2
Filing test	Easily workable	Not easily workable
Indentation test	Punch tip makes indentation in workpiece	Punch tip gets blunt
Sound test	Dull, deep tone	High tone
Bending test	Bendable multiple times	Not bendable
Spark test	Light sparks	Dark red sparks

Fig.156: Table of observations

Stage 5: Evaluation of experiment / results

For the evaluation of the experiment, the trainer goes through each workshop test with the trainees and asks them to explain the background.

As a result of the **filing test** there is general agreement that Material Sample 1 is easily workable and shows less strength, whereas Material Sample 2 is hardly workable and high strength.

Through the **indentation test** it is clear that the comparative surface hardness of Material Sample 1 is low, but Material Sample 2 is high.

Based on the **tone pitch** that was heard in the sound test, it can be deduced that the connecting forces of Material Sample 1 are fairly elastic, while Material Sample 2 is more rigid.

In the **corner bending** test Material Sample 1 demonstrated a high degree of elasticity and Material Sample 2 had a greater hardness and brittleness in comparison.

The **spark test** for Material Sample 1 showed light red sparks, which are an indication of low carbon content. Dark red sparks indicate a comparatively high carbon content as seen in Material Sample 2.

The trainer asks the class to discuss and formulate an overall result. The trainees come to the following conclusion:

When a comparison is made based on each workshop test, it can generally be concluded that Material Sample 1 is a highly workable, elastic material, which means that it must be mild steel. Material Sample 2 demonstrates high levels of strength and hardness but little elasticity, which means that it must be tool steel.

The trainer confirms these results and informs the trainees that Material Sample 1 is mild steel S235JR and Material Sample 2 is tool steel C110.

3.8 Training course

3.8.1 Basic principles

Training courses have a long tradition in many fields, besides in industrial and technical vocational training. The method of teaching specific knowledge and skills in a targeted manner by breaking down the content into clearly structured parts, according to the principles of “from easy to difficult” and “from simple to complex”, is regarded as a typical element of training courses.

Training courses exist for all kinds of vocational activities.

During a practical training course in “planing by hand” for woodworkers, the trainees practise smoothing wood surfaces with various planes.

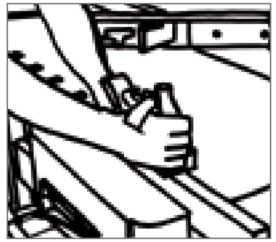


Fig. 157: Trainee working with a plane

During the training course “soft-soldering”, the trainees use soldering irons, solder and flux to join two copper plates together.

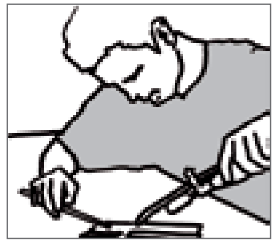


Fig. 158: Trainee performing soft-soldering

A car mechanic attaches clips to the measurement points in the car motor as shown in the photo during the training course in motor testing.

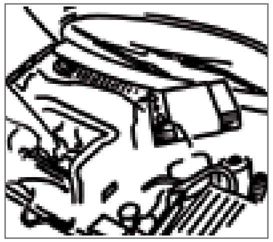


Fig. 159: Motor test

A mechanical engineer constructs a vertical welding seam during the training course in "electric welding".

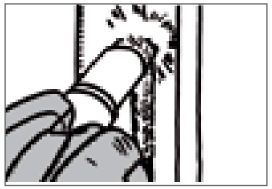


Fig. 160: Construction of a vertical seam

During a training course in "gas welding", a trainee practises bonding two metal plates together using gas welding as part of the training to become a plumber and plant mechanic.

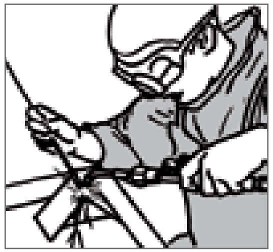


Fig. 161: Gas welding of two metal plates

The starting point for the organisation of the content in a training course is a target qualification. This target qualification is divided into separate learning objectives and learning content to determine separate, logically ordered learning steps.

If trainees participate actively in the course, they will be able to achieve the objectives that are required for the target qualification. For the trainer, therefore, a training course concept that is easy to plan and implement guarantees reliable teaching. Well-designed training courses almost always result in the desired outcome. The separate learning sequences in the training course are taken out of the complex context of technical, specialised work and reduced to specific, simplified work steps.

The procedure for a training course can be divided into five stages:

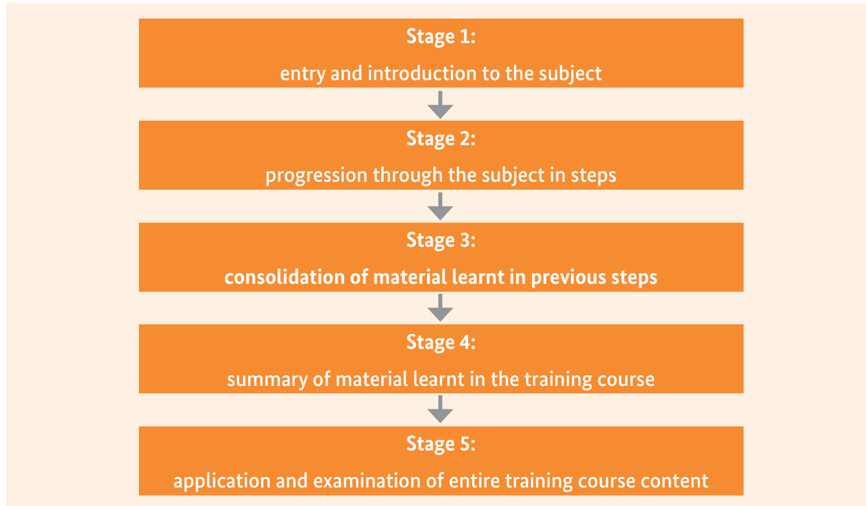


Fig. 162: Sequence of steps involved in a training course

Training courses are a useful means of conveying technical knowledge and basic technical information. Due to its systematic structure and action-oriented procedure, the training course enables trainees to perform a variety of tasks that range from simple to complex and cover a comprehensive range of topics, which is particularly good for developing their skills.

However, because the training course is trainer-centred and follows a precisely planned sequence, the trainees' creativity and independence could be inhibited. There is a tendency for them to follow and imitate.

The following table provides an overview of the training and lesson procedure (Fig. 163).

Assessment criteria	Training course
Characteristics	The training course is characterised by a systematic structure. It can be used in a targeted manner without the need for developing variations. It can easily be planned in advance and enables time-efficient learning. The primary objective of the training course is to convey technical knowledge, abilities and skills. This is carried out systematically and based on appropriate training course materials.
Learning objectives	The trainees learn to ... - understand the components of a training course - perform practical exercises during each stage of the training course - practise specific work techniques or operations - combine the separate learning sequences to meet the overall requirements for a qualification - develop work competence - work responsibly, both independently and in a group (team)
Procedure	1) Lead-in 2) Overview, or introduction to the subject 3) Progression through the subject in small steps 4) Consolidation of the material learnt in these steps 5) Summary of the material learnt in the training course 6) Application and examination of the contents of the entire training course

Fig. 163: "Training course" - an overview

3.8.2 Sample lesson: training course in the subject of "machine technology"

The subject of the training course is: "arc welding". As a prerequisite, trainees must have basic electrical technology knowledge. The objective of the course is to acquire important knowledge and skills in welding.

Phase 1: Stage 1: Lead-in and breaking down the subject into steps

The trainer gives the trainees a general overview of welding and the target qualifications. The overview explains the significance of welding as a joining technique in order to understand the practical task at hand. The trainer uses the overhead projector to show the trainees three basic types of welding.

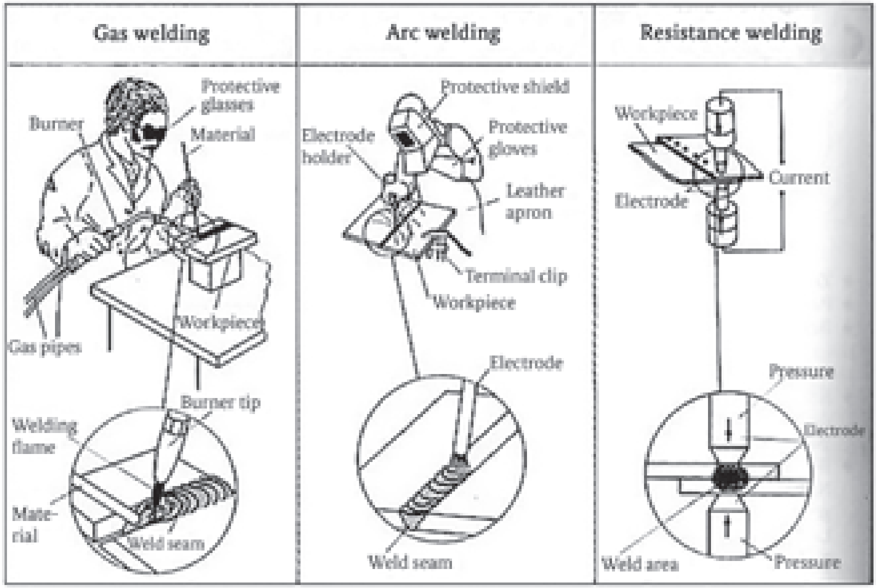


Fig. 164: Three types of welding

During a training course it is particularly important to interest the participants in the subject, particularly if the training session has been ordered by the company and takes place in another location. The trainees are given a detailed description of the training course.

The trainer demonstrates arc welding of a v-weld. The trainees observe the welding process from behind protective shields.

The work procedure looks simple to the trainees. They feel motivated to try it for themselves. It is important to let the trainees know the overall context as well as making each step clear. This prepares them for the next step and makes it easier for them to orientate.

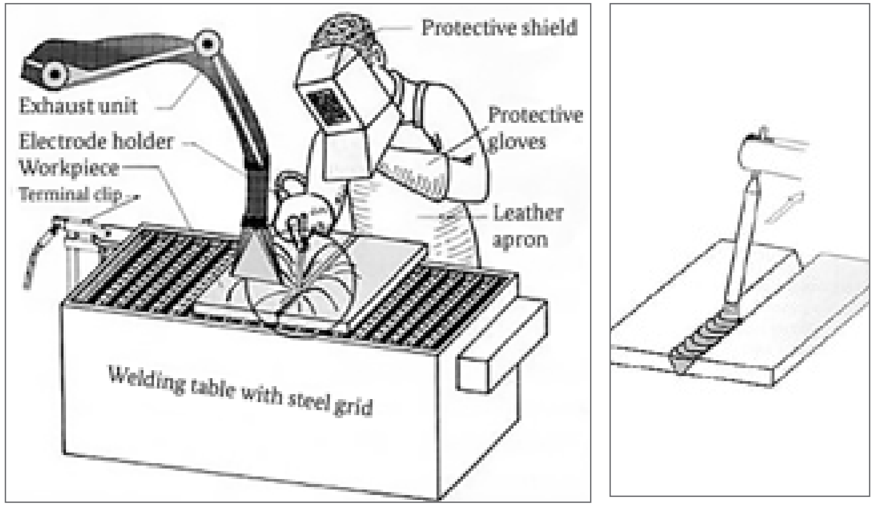


Fig. 165: Trainer demonstrates correct work procedures for arc welding

Stage 2: Progression through the subject in small steps

The trainer shows the trainees the welding equipment.

First, the trainer explains the welding generator.

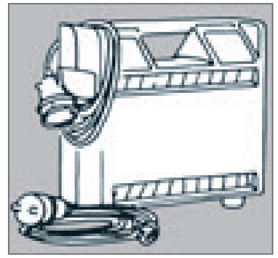


Fig. 166: Welding generator

Next, the trainer shows the trainees the electrode holder and demonstrates how to clamp in the electrode.

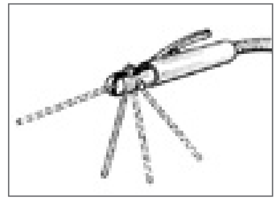


Fig. 167: Electrode holder

To close the electric circuit, the workpiece also needs to be connected to the welding generator. This is done with terminal clips.

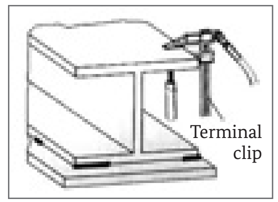


Fig. 168: Terminal clips

Fig. 169: Protective shield and protective clothing

The trainer names the protective equipment for arc welding and explains its functions.

The protective face shield protects the welder's face and eyes from injury.

The protective hood allows the welder to keep both hands free while working.

Protective clothing made of flame-retardant material protects the welder from burns.

A wire brush is used to clean the surface of the work-piece before and after welding. The slag left over after welding is removed with a pick hammer.

There are various kinds of welding electrodes available. The electrodes also serve as additional material, because they fill up the welding seam when they melt.

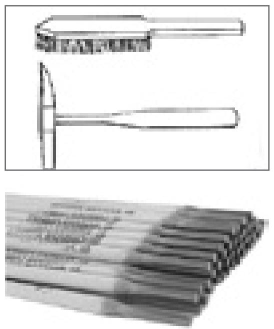


Fig. 170: Wire brush, chipping hammer, electrodes

To strike the arc from a welding electrode, tap the electrode briefly onto the welding seam area to create a temporary intentional short circuit. This allows the electric current to flow through the electrode, heating up the tip and the surrounding air, which also becomes electroconductive.

Lift the electrode off and hold it above the workpiece at a distance approximately equivalent to the diameter of the bead wire. The current now flows through the electroconductive air and creates an arc as intended.

If the distance is too small, the electrode sticks to the workpiece. If the distance is too large, the arc becomes uneven, fluctuates and breaks.

Because the electrodes melt during welding, the welder needs to refill them evenly.

Guiding an electrode along a weld seam requires a great deal of practice. When the material of the weld seam starts to melt after you have struck the arc, guide the electrode slowly in the welding direction. As a rule, welding is performed from left to right. The electrode is held at an angle of about 45 degrees in the direction of welding.

For welding in a transverse direction, it is held at an angle of 90 degrees.

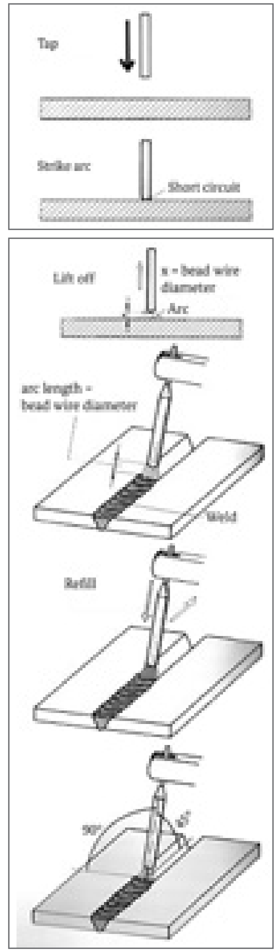


Fig. 171: Welding procedure

The angle is important for the quality of the weld seams. The quality is also determined by how the electrode is moved.

If the electrode is moved in a straight line in a forward direction, without any sideways movements, the weld bead will have a striped appearance.

For larger seams, the electrode should be moved in a pendulum fashion while proceeding in a forward direction. The resulting weld bead will be broader.

When the slag has hardened, tap it off carefully with a pick hammer. Then, use a wire brush to brush off the remaining slag from the seam.

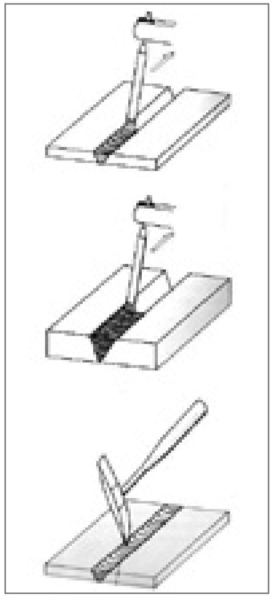


Fig. 172: Welding procedure

After demonstrating these work steps, the trainer gives the trainees their first welding assignment. The trainees will start with the welding exercise “creating a V seam”.

The trainer examines the trainees’ welding efforts and allows them to continue practising. Using these samples, the trainer explains common welding mistakes and their causes.

The causes of an insufficiently deep weld seam are

- the gap between workpieces was too small
- the current was too low
- the arc was too long

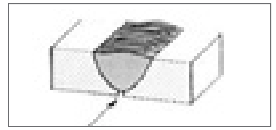


Fig. 173: Shallow weld seam

The causes of an overhanging weld seam are

- the gap between workpieces was too large
- the current was too high
- the arc was too short

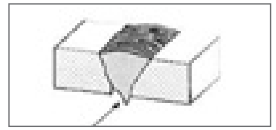


Fig. 174: Overhanging weld seam

The causes of a convex weld seam are

- the current was too low
- the welding speed was too slow

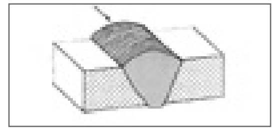


Fig. 175: Convex weld

The causes of undercuts are

- the current was too high
- the distance between workpieces was too large
- the welding speed was too fast

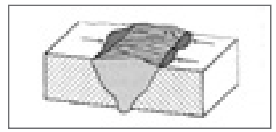


Fig. 176: Undercuts

The causes for internal errors in the weld are

- the electrode was moved incorrectly
- an inaccurate assessment of the weld pool and the slag runoff
- impurities in the weld joint.

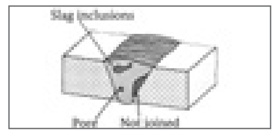


Fig. 177: Internal errors

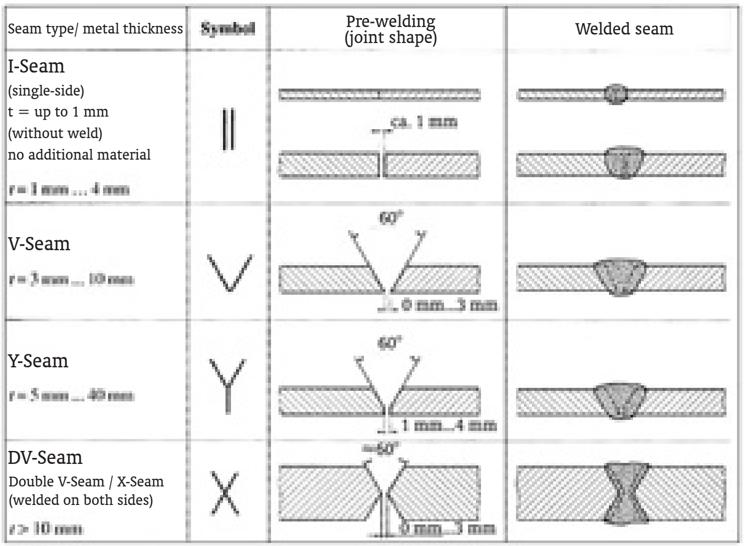
Finally, safety concerns are discussed. To avoid life-threatening electric shocks, the welder must never touch the workpiece and the live components of the electrode at the same time.

The following essential rules must be observed:

- Use only undamaged welding cables in accordance with regulations! The insulation on the electrode holder must also be completely free of damage. Immediately replace any defective holders.
- Always use leather gloves when handling electrode holders. Never hold them in place under your arm when pausing during welding! Always use a suspension device to prevent electric shocks.
- Never perform arc welding during rain or on wet metals – this may result in death!
- Never sit or lean on metal or wet surfaces while welding, without using an insulating layer of wood or rubber.
- Stricter safety regulations apply for welding insides of containers. This work should only be performed by highly experienced qualified welders.

Stage 3 a: Consolidation of the learnt material

The trainer shows the trainees a table of various weld seam types. The trainer asks the trainees to weld I seams, V seams and double-V seams.



Seam type/ metal thickness	Symbol	Pre-welding (joint shape)	Welded seam
I-Seam (single-side) t = up to 1 mm (without weld) no additional material t = 1 mm ... 4 mm	‖	ca. 1 mm	
V-Seam t = 3 mm ... 10 mm	V	60° 0 mm...3 mm	
Y-Seam t = 5 mm ... 40 mm	Y	60° 1 mm...4 mm	
DV-Seam Double V-Seam / X-Seam (welded on both sides) t > 10 mm	X	≈60° 0 mm...3 mm	

Fig. 178: Table of weld seam types

The trainees perform the welding exercises. The mistakes that occur during the different welding exercises are discussed.

Stage 3 b: Further consolidation of learnt material

To deepen their knowledge, the trainees are given the task of welding a fillet weld, which should be built up in several layers. The trainees are told that the metal plates should be perpendicular to each other, and that they should be tacked together first.

The trainees start with the tack welding procedure. Next, they perform multi-pass welding.

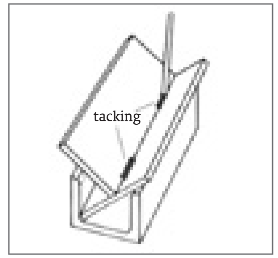


Fig. 179: Tack welding the workpieces

In many cases, the desired seam thickness cannot be obtained with just one pass.

Therefore, the seam needs to be welded in stages, by building up multiple layers until the desired thickness is reached. This technique is known as “multi-pass welding”.

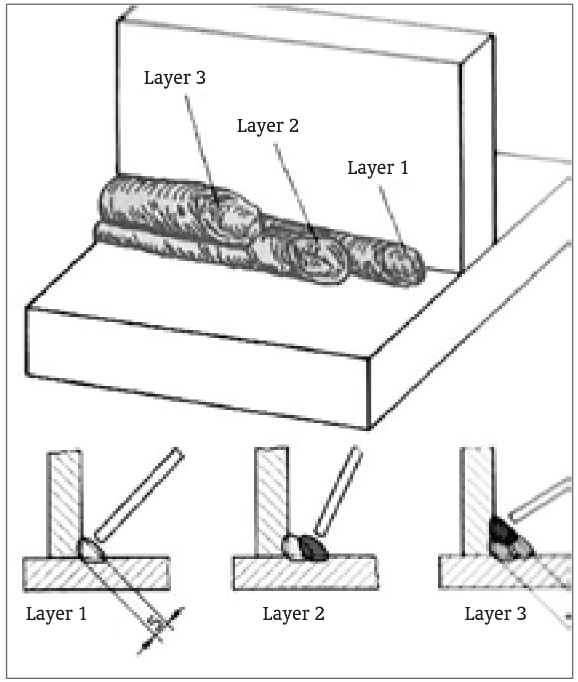


Fig. 180: Multi-pass welding

The trainer evaluates the trainees' work and lets the trainees continue practising. Then, the trainer points out the difficulties that might be encountered during manual arc welding and describes the work procedure.

To deepen their knowledge even further, the trainees are given the task of welding a vertical seam. The trainer explains that the molten metal has the tendency to drip downwards. Therefore, a vertical seam is built up from the bottom to the top, which prevents the slag from dripping into the weld material.

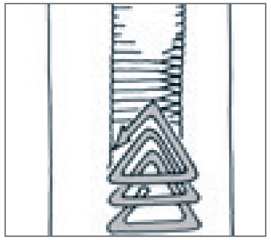


Fig. 181: Vertical seam, "pine tree"

First, the metal pieces must be positioned so that they are perpendicular to each other. Next, the pieces are tack welded.

The trainees attempt to construct a vertical weld seam. They realise that the electrode needs to be moved in a specific way when the metal plates and seams are thicker.

Next, the trainees are given various exercises in welding in different positions.

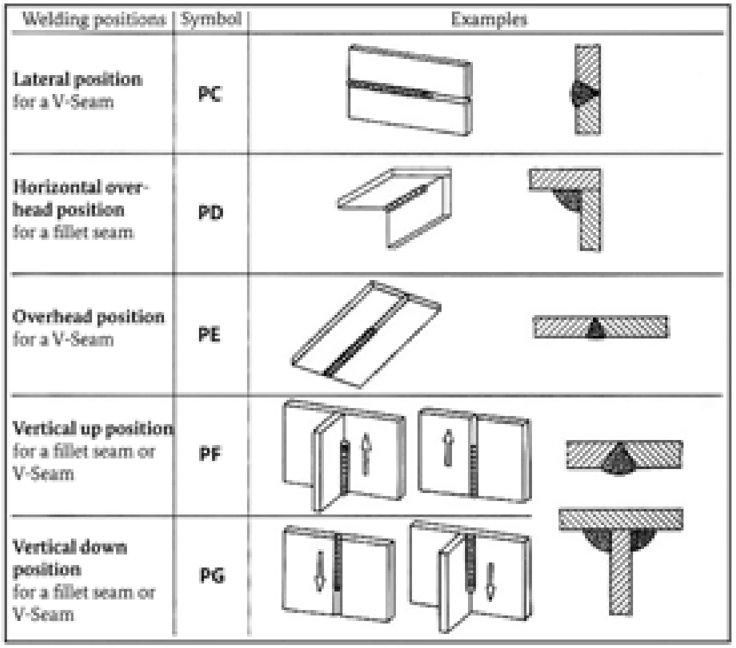


Fig. 182: Exercises in welding

Stage 4: Summary of the material learnt in the training course

The trainees summarise the most important points that they learnt from their welding practice and demonstrate their knowledge by performing a more complex final exercise. The task is as follows: a pipe (diameter: 60 mm, thickness: 5 mm) needs to be welded to a flange (outer diameter: 160 mm, inner diameter: 60 mm and flange thickness: 20 mm). The appropriate welding electrodes and generator current must be selected.

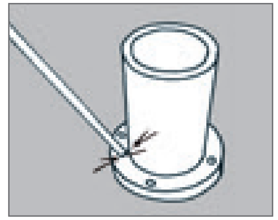


Fig. 183: Welding "pipe and flange"

After discussing the task, the trainees understand that one person has to keep turning the flange while the other person welds, to allow the welder to maintain the same position.

Finally, the trainees describe the work process and explain each step, identifying possibilities for improvement if necessary. The trainees discuss other types of welding work, referring to concrete examples of welding applications.

Stage 5: Application and examination of the entire training course content

For consolidation and revision, the trainer asks the participants in the training course a series of questions. Sample questions may include the following:

1. Describe the different types of welding generators and state the advantages and disadvantages of each.
2. What is the purpose of the coating on the welding electrode?
3. Why must extraction systems be used during arc welding?
4. Explain the function of the electrode holder and the workpiece clamp.
5. When is a welding jig necessary?
6. Name some important auxiliary tools that are used in arc welding.
7. Describe the applications for thick-coated and thin-coated electrodes.
8. What are the work rules for the preparation of workpieces before arc welding?
9. What are the grounds for the selection of welding electrodes?
10. How is the strength of the welding generator current determined?
11. Name the accident prevention measures that must be taken for arc welding.
12. Describe the work steps for welding a corner seam.
13. What is the function of the slag that is formed during the welding process?
14. What is the function of the protective shield and protective glasses when arc welding?
15. What does the welder need to know about the thickness of weld seams?
16. Why are weld seams often welded in multiple layers?
17. Describe some common welding mistakes and name the measures that can be used to prevent them.

Finally, as a final examination, the trainees are given an exercise that should be completed in writing.

The main purpose of the final assessment is to reflect on the subject and tasks of the training course as well as the training course in “electric welding” as a whole. The trainer presents the trainees with a certificate, which confirms that they have successfully completed the training course.

3.9 Guiding-text method

3.9.1 Basic principles

The guiding-text method follows the principle of self-contained activity: inform, plan, decide, execute, check, evaluate. Therefore, the method is a very close approximation of the requirements of complex vocational tasks. The basis of the method known as the “guiding text” encompasses the four elements of guiding questions, work plan, check sheet and guiding-text principle. These are structured in the form of results-oriented learning tasks and work tasks. Didactically considered, the guiding-text method is an extended version of the four-step method, consisting of six steps. It also basically follows the principle of (work) instruction.

Work specifications as text can be found in diverse forms in the everyday working world. These might include a label on a workpiece, an engineer’s technical specifications or a form for an inquiry. All of these specifications in text form guide the work process in steps and serve as a set of instructions. The guidelines that are connected by all of these texts can be developed into a method for vocational learning.

The guiding-text method helps people who are learning a trade to perform complex work tasks independently.

The basis for this is the model of self-contained action. This consists of the steps of planning (action plan and action goal), the implementation of planned actions and control of results. This sequence is characteristic of action-oriented, integrated learning. It serves to promote independence.

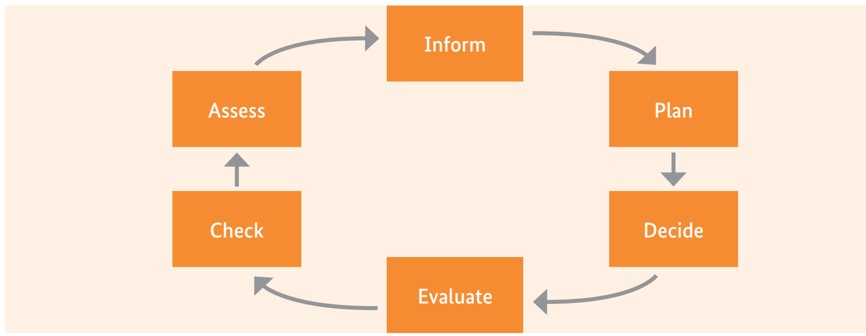


Fig. 184: Cycle of self-contained activities

The training and lesson procedure that is based on this method can be summarised in the overview below (Fig. 186).

Assessment criteria	Guiding-text method
Characteristics	The guiding-text method is an action-oriented, integrated system for training and education. The trainees plan a complex work process and implement it. The work process is structured by the guiding questions or the guiding texts. It is suitable for trainees who would like to work independently but need a helping hand for the organisation and structuring of a work process.
Learning objectives	The trainees obtain the ability to ... - Take responsibility for their learning and working - Gauge their work pace accurately - Plan their work thoroughly and creatively - Implement planned work independently - Strengthen their teamwork skills - Check their own work performance
Procedure	1) Motivate 2) Inform 3) Plan 4) Decide 5) Implement 6) Check 7) Assess

Fig. 185: Guiding-text method – an overview

3.9.2 Sample lesson: guiding-text method in the vocational field of "electrical engineering"

The content of this guiding-text method lesson is the construction of an electric circuit (relay for stairwell lighting with automatic switch-off function). The trainees must have basic knowledge in electrical engineering. The objective of the lesson is for trainees to understand the most important knowledge and skills for the construction of a circuit.

Stage 1: task outline and information

Trainees who are training to become electricians are given the work assignment of constructing a circuit for stairwell lighting. This involves a relay for a manual switch that can be switched on and switches off automatically without a self-holding function. The battery voltage should be 12 V.

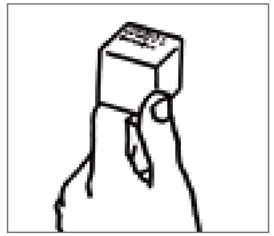


Fig. 186: Trainer shows relay

The circuit must be planned so that the relay takes in as little electricity as possible when in a closed state. The trainer shows the trainees an industrially produced relay.

The trainees inform themselves about the parameters of the relay. These are:

I_a – Starting current: the current that activates the relay.

I_h – Holding current: the current which is just enough to allow the relay to remain active.

R_r – Resistance of the relay coils.

Stage 2: Planning

Before the trainees start planning, they recognise that this kind of electric circuit is characterised by a relatively high demand for electricity, particularly when starting.

Therefore, the trainees take into account that the excitation that is needed for holding is significantly smaller than that needed for starting.

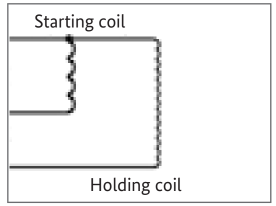


Fig. 187: Holding coil and starting coil

They recognise that an advantageous planning strategy would be to include two coils for the relay.

The trainees also discuss the possibility of completing the task by producing a circuit that uses a relay with only one coil.

The trainees plan and design the circuit and draw the circuit diagram.

To check whether the circuit diagram meets the requirements of the task, the trainees prepare a functional description by way of trial. When the manual switch T is opened, the capacitor C becomes charged via series resistor Rv. When the switch is closed, the capacitor discharges via the relay and the relay switches on. The current flowing through the activated relay is limited by the series resistor. The holding current must still be high enough to keep the relay activated.

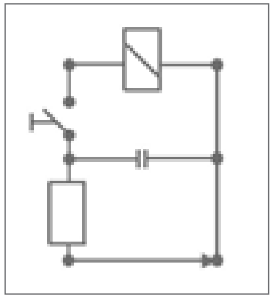


Fig. 188: Circuit diagram for installation of relay

Stage 3: Decision and implementation

The trainees decide to construct the circuit based on the diagram that they have developed. Before implementing the plan, the trainees need to determine the dimensions of the components. The trainees note down the most important sizes on the circuit diagram.

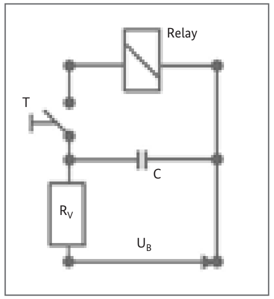


Fig. 189: Circuit diagram for installation of relay – with labels

The input voltage U_B amounts to 12 Volts.

The series resistor for the relay coil is a fixed size that corresponds to the relay. When the manual switch is closed, the holding current Ih should flow. The total resistance R_g in the circuit is: $R_g = R_v + R_r$

Ohm's law states that: $U = I\,R$

To determine the resistance, this becomes: $R = U/I$

Therefore, to calculate the total resistance in the circuit: $R_v + R_r = U_B/I_h$

I_h and R_r are read or measured at the relay.

To construct the circuit, the trainees prepare the necessary components, tools and materials. The trainees take the relay and check the values printed on it.

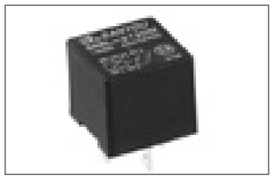


Fig. 190: Relay

The trainees measure the parameters of the relay (starting current I_a and holding current I_h) using the multimeter with the circuit set up as pictured.

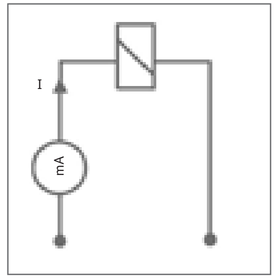


Fig. 191: Circuit diagram for measurement

The relay coil resistance R_r can also be determined using the multimeter.

Fig. 192: Multimeter

The functionality of the manual switch is also tested.

Fig. 193: Manual switch

The resistors to use for R_v are distributed. The trainees select a suitable resistor.

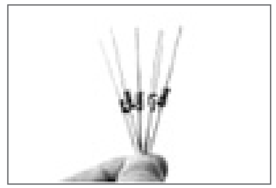


Fig. 194: Resistors

Also, a variety of capacitors are made available to the trainees.

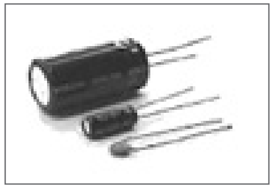


Fig. 195: Capacitors

The tools made available to the trainees include a variety of electric soldering equipment with soldering pliers.

Fig. 196: Soldering gun and soldering pliers

Also, a range of soft solder is made available.

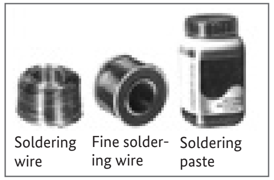


Fig. 197: Soft solder - varieties

Next, the trainees construct the circuit according to their plans, using the series resistor that they selected, and the capacitor C that they determine by means of an experiment.

The capacitor size needs to be large enough to activate the relay when it closes.

Therefore, the trainees try out a variety of capacitors to find the most suitable one.

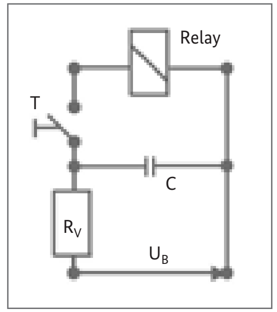


Fig. 198: Various capacitors are tested

Stage 4: Evaluation

The trainees reflect on the whole process from the receipt of the assignment to the completion of the circuit. They discuss the possibilities for improvement. They also consider how the project would have worked with only one coil for the relay. The trainees examine a relay with a coil after removing the protective cover.

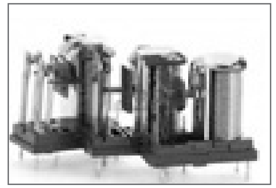


Fig. 199: Switching relay without cover

The trainees recognise that the mechanical relay works according to the principle of electromagnetics. When the current flows through the excitation coil, one or more contacts are moved. The armature is pushed back to the starting position by spring force as soon as the current stops flowing through the coil.

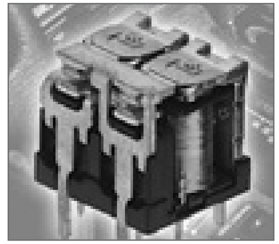


Fig. 200: Double coil relay

Stage 5: Check

The trainees check their solution to the task. To do so, they connect a battery with voltage U_B = 12 V to the clamps at the voltage source and measure the operating current. If the relay activates smoothly when the manual switch is closed, and when the resulting current is equivalent to or only slightly larger than the holding current for the relay, the assignment has been completed successfully.

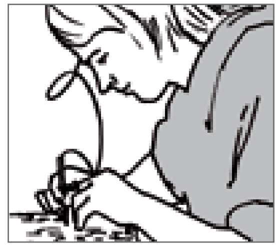


Fig. 201: Trainee measuring with a multimeter

Stage 6: Assessment

The trainer helps the trainees to evaluate the circuit diagrams and the completed circuit for the stairwell lighting. They discuss how long the light in the stairwell needs to stay switched on. Then, they evaluate the task as a whole.

Finally, the trainer hands out some questions for consolidation and review:

1. What is the function of a relay?
2. How is the resistance of the relay measured?
3. What is the function of the series resistor?
4. How does the capacitor work?
5. What is Ohm's Law?
6. What needs to be noted when constructing a circuit according to a circuit diagram?
7. Which tools and equipment need to be supplied for this task?
8. Explain the difference between the processes of "soldering" and "welding".
9. How is the strength of a solder joint determined?
10. Describe the soldering tools needed for soft soldering.
11. What information is necessary for ordering soft solder?
12. What is the function of flux in soldering?
13. Why must workpieces always be prepared before soldering?
14. How do you rid a soldering joint of impurities and oxides?
15. How is the soldering of the capacitors and resistors in the circuit carried out?

3.10 Work task as method

3.10.1 Basic principles

Work tasks represent a new methodological concept for company-based vocational learning. They place an emphasis on the close connection between vocational learning and work in practice.

Work tasks must demonstrate relevance for operational tasks. These are the tasks that are performed during business and work processes for real work orders. With this focus, vocationally relevant technical work and technology can be selected and didactically developed for work tasks.

They are an ideal means of preparing trainees who are learning a trade for operational activities. As a challenge to the trainees to learn actively, work tasks combine the work processes and work content that can motivate the trainees. The trainees have to perform a specific action in a thoughtful and appropriate manner, answer a question, solve a problem, implement a set of instructions, carry out a task or make a decision. They should ask questions themselves that can help them to shed light on a problem area.

It should be noted that not every activity has equal amounts of learning potential. Work aspects need to be examined very carefully before they can be classified as meaningful learning material. In particular, work tasks that allow for alternative solutions are often regarded as interesting to work on.

Work tasks can be derived from work situations in practice but they can also contain constructed problems. The work tasks support the processes of identifying and solving work-related problems. They also provide the trainees with opportunities to access the learning content and to organise their own learning process by working independently as well as cooperatively.

Both mental and manual work should be integrated into one unified process for the work task. The trainees work out the solution of a task by combining their theoretical technical knowledge as well as general knowledge with practical experience and applying it to the problem. This results in interplay between thinking and doing, which progresses through several stages under favourable conditions.

The trainer usually provides the tasks. However the trainees can also formulate the tasks themselves or select them from amongst a range of options. Another possibility would be for the entire group to develop and formulate the work task together.

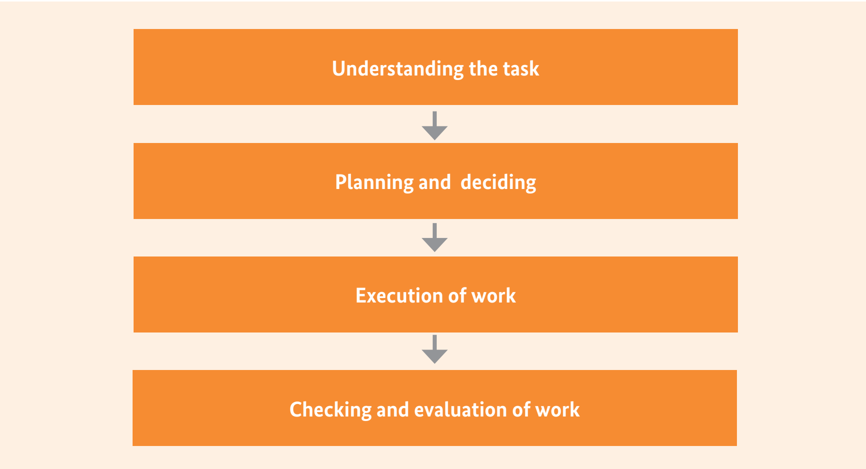


Fig. 202: Sequence for carrying out a work task

The following overview outlines the basic principles of the work task:

Assessment criteria	Work task
Characteristics	Work tasks establish a close connection between vocational learning and working. They enable trainees to independently access content with technical, procedural and general learning requirements. Work tasks have great relevance in the employment system and therefore also for vocational learning processes.
Learning objectives	The trainees will be able to - understand and plan a work procedure, - carry out a work task independently for the most part, - check their work performance.
Procedure	The articulation steps are based on the concept of self-contained activity starting with understanding the assignment and collecting information (1), planning and decision-making (2), implementation of the work (3), checking the results (4).

Fig. 203: Work task – an overview

3.10.2 Sample lesson: work task in the vocational field of "automotive technology"

The trainees are familiar with the composition of a combustion engine. They can explain the four strokes and describe how a motor works. They already have some experience participating in repair work on a car motor.

Stage 1: Understanding the task and collecting information

The trainees are told that the compression in the engine is no longer sufficient and the valves do not close properly any more. They are given the task of disassembling the engine block, removing the cylinder head, and machining the valve seats with a grinding machine.

The trainees take a look at the engine in the motor vehicle. They go through their existing knowledge to deduce how this kind of work task should be performed professionally, what work steps they will need to take and which tools they will need to use.

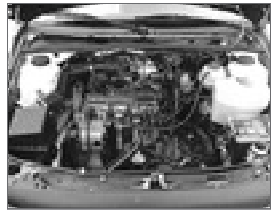


Fig. 204: Engine compartment in a motor vehicle

Stage 2: Planning

The trainees draw up a work plan. They list the most important work steps:

- take off engine cover
- remove valves and perform a visual inspection
- start valve seat grinding machine
- machine valve seats
- check quality of valve seats
- install valves
- attach cylinder head to engine block and set engine control unit
- measure compression
- test run the engine

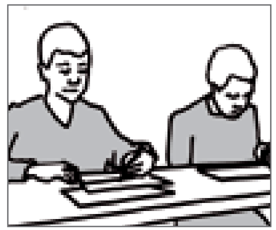


Fig. 205: Trainees doing work planning

Stage 3: Execution of work

The trainees put protective sheets over the car body so they do not damage it when performing disassembly and assembly work on the engine. They disassemble the entire engine block or only the cylinder head. Then, they take the valves out of the cylinder head.

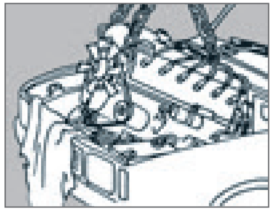


Fig. 206: Disassembly of engine

The trainees are given a drawing of the valve seat grinding machine. They label the components of the machine and become familiar with the equipment.

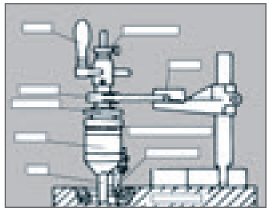


Fig. 207: Valve seat grinder (unlabelled)

The trainees compare and check their answers as a group.

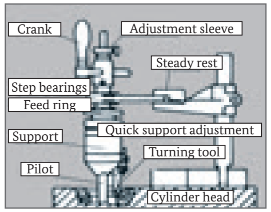


Fig. 208: Valve seat grinder - labelled

Next, the trainees set the machine on the disassembled cylinder head and start the grinding process.

To do this, they set the feed rate and the depth of cut. Once they have completed the grinding work, the valve seat grinding machine is taken off the cylinder head. The machined valve seat surfaces are cleaned and given a visual inspection before they are reinstalled in the valves.

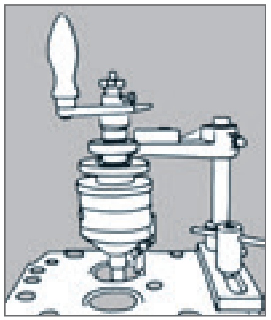


Fig. 209: Valve seat grinder

The trainees assemble the valves. They attach the cylinder head to the engine block and set the engine control unit. The trainees determine the specified torque for the cylinder head screws. Using a torque wrench, the trainees tighten the cylinder head screws.

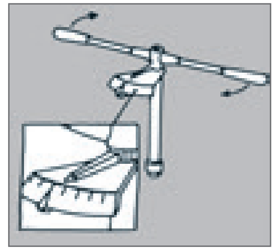


Fig. 210: Torque wrench

Stage 4: Checking and evaluation of work

After they have reassembled the engine, the trainees measure the compression in all cylinders.

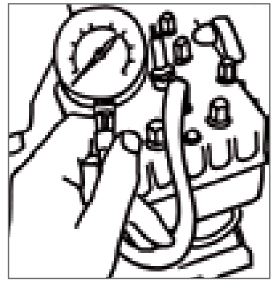


Fig. 211: Measuring compression

Finally, the trainees perform a test run of the engine. The trainer conducts a concluding discussion to enable the trainees to ask specific questions related to the work task and the completion of the work. During the discussion the trainer also emphasises that the measuring device for the valve seats can only be used for valve seats made of grey cast iron and mild steel, and not for valve seats made of chromium-nickel steel and carbide.

3.11 Practical project

3.11.1 Basic principles

Working with projects can be regarded as one of the highest stages of action-oriented learning in practice. Practical projects have particular significance, because at the completion of the project there must be a finished product. Such projects are very valuable for the purpose of practical learning, because they allow the trainees a great deal of room for manoeuvre and are also very concrete.

The typical characteristics of a practical project include

- the amalgamation of previously unrelated content
- the problem-oriented solving of tasks
- the alignment of the task with the interests of the trainees
- the progression through all stages of self-contained action by the trainees
- self-organisation and acceptance of responsibility by the trainees

The special feature of the practical project is the extent of freedom that trainees have to organise the work process. In an ideal case, although the trainees do not plan the product by themselves, they do plan the work path towards the finished product. The biggest difference between this and other methods is that there is a greater degree of openness at the outset and also during the associated work for the practical project. This demands a lot more creativity from the trainees. The main objective is to find solutions that are appropriate for the technical task. As an opportunity for independent problem solving, it provides trainees with incentives for learning technical knowledge and practising technical skills beyond the usual narrow scope of problems and topics.

The most crucial and fundamental objective of working with projects is the promotion of independent actions, that is, the trainees' action competence. This highlights one of the most important characteristics of the process: working together with others or the cooperation between trainees and trainer as well as cooperation amongst trainees. In addition, the trainer can focus on different objectives depending on the type of activity involved in the trade and teach these in depth, selecting the appropriate content. These differences can be clarified by the following examples:

Trainees studying to become carpenters / joiners plan and manufacture a "toolbox made of wood-based materials". To do this, they use manually operated machine tools.

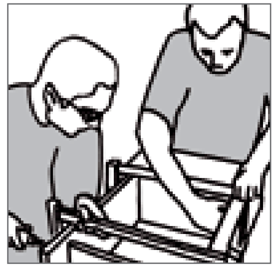


Fig. 212: Practical project in woodwork

The practical project "fireside companion set" represents a particular set of tasks for metalworkers. Another popular project is the manufacture of elaborate iron gratings for protecting windows.

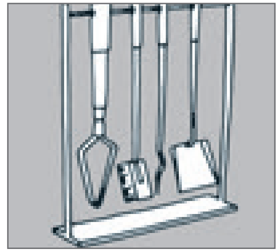


Fig. 213: Fireside companion set as a practical project for metalworkers

As part of the vocational training for car mechanics, exercises in building solar vehicles are a popular choice for practical projects.

These vehicles rely exclusively on solar power for operation.

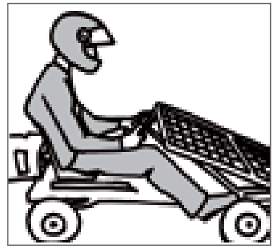


Fig. 214: Trainee with solar vehicle

In the vocational field of mechanical engineering, trainees develop skills in cooperating with others as well as working alone through the practical project "drill vice". They plan, manufacture and check their products.

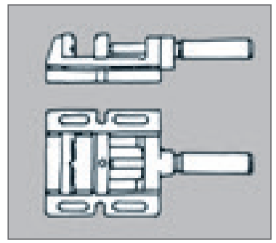


Fig. 215: Practical project "drill vice"

The complete planning and installation of a bathroom is a project that is also challenging in practical terms. The trainees plan their products largely by themselves, and then carry out and evaluate their own products.

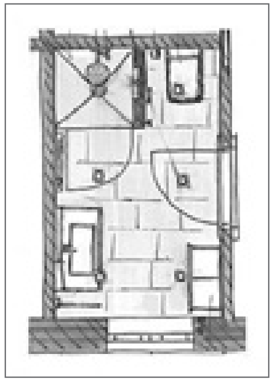


Fig. 216: Practical project "bathroom planning" for sanitary facilities technicians

Trainees studying electrical engineering build their own simple transistor radios. They draw up a plan by looking for simple circuit diagrams, select the required parts and then construct the device themselves. Finally, they test the quality of the reception.

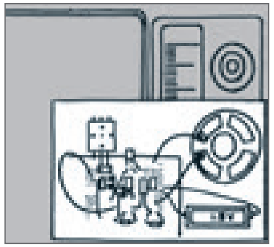


Fig. 217: Practical project in electrical engineering

Practical projects can be used to achieve a variety of technical learning objectives. In addition, some of the "higher" learning objectives that go beyond the subject material are

- identification of problems that arise during the planning, implementation and utilisation of technical products
- formulation of hypotheses and approaches to problems
- cooperation and communication with other trainees in the group
- efficient use of information materials, specialist literature and equipment
- improvement of decision-making skills
- increase in the ability to make judgements and support them with reasons
- identification of interdisciplinary, ecological, social and societal aspects.

Stage 1:
Trainer and trainees initiate the practical project with a specific task..

↓

Stage 2:
A project outline is drawn up to serve as a rough guide.

↓

Stage 3:
The trainees plan the final product and the construction process by themselves.

↓

Stage 4:
The trainees manufacture the products for their practical projects.

↓

Stage 5:
Evaluation and comparison of the finished products round off the practical project.

Fig. 218: The five stages of practical projects

Assessment criteria	Practical project
Characteristics	Practical projects integrate previously learnt material into a unified whole. The trainees work on a whole project, largely independently and in cooperation with others. From planning to approval, they progress through all of the stages of self-contained work activity. At the same time, they also pursue interdisciplinary learning objectives.
Learning objectives	The trainees will be able to - plan and implement a project task throughout all stages - work on the project task independently and cooperatively - think ahead to identify bottlenecks and develop pre-emptive solutions - evaluate the significance of their work from an interdisciplinary point of view
Procedure	During the project, the trainees work through steps such as starting a project initiative, creating a project outline, developing the project plan, implementing the project and finishing the project.

Fig. 219: Practical project – an overview

3.11.2 Sample lesson: practical project in the vocational field of "woodworking"

Stage 1: Trainer and trainees initiate the practical project together

The trainees are asked to plan and complete their own products, working independently and cooperatively. Together with the trainer, the trainees think about the kind of product that they would be able to make under the specified conditions and in the available time. The specified conditions are:

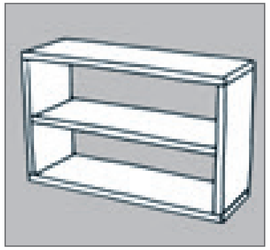


Fig. 220: Wooden shelving

The required product is shelving made out of wood or wood-based materials. It should be constructed with hand tools and hand-held machines (circular saw, power drill).

The trainees decide to make a small bookshelf with an intermediate shelf. Depending on their level of experience and technical knowledge, the trainees select variations on this project in different degrees of difficulty. The options are:

a. **Manufacture only the basic bookshelf with an intermediate shelf.**
b. **Manufacture a bookshelf with an intermediate shelf and a rear panel.**
c. **Manufacture a bookshelf with a backing panel and two doors.**

The overall objective of manufacturing the shelf is also to demonstrate skills in working with machine tools. After completing the project, the trainees are allowed to take their bookshelves home with them.

Stage 2: Trainees prepare a product sketch as a rough guide

The trainer tells the trainees the amount of material in sq.m. that each person is allowed to use for their bookshelf.

Stage 2a: In groups of three, the trainees prepare rough sketches and models of the bookshelf with a scale of 1:5 and calculate the approximate dimensions. At this stage, they start considering the corner joints for the components. If applicable, they also sketch out the construction of the backing panel and the doors.

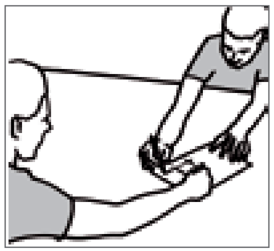


Fig. 221: Trainees draw rough sketches

Stage 2b: Next, the trainees start considering what kinds of equipment they will need to use, how long the construction will take and what criteria should be used for evaluating the product and its manufacture.

The trainees present their provisional plans. They compare and discuss these with the class. Working together with the trainer, the trainees agree on some basic guidelines to follow during the next steps, which will apply to all groups. These guidelines might refer to conditions such as the time frame, the applicable materials and tools, the work steps and the evaluation criteria.

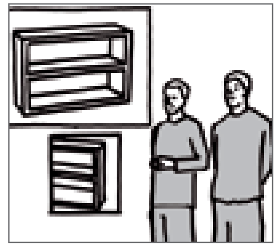


Fig. 222: Presentation of provisional plans

Stage 3: The trainees work independently to plan the final product and the manufacturing process.

In this stage, the trainees plan their projects based on the results of stage 2b. They create accurate drawings of the bookshelf. In addition, the trainees organise their next work steps. They practise professional work planning by drawing up a detailed table. This outlines the work steps, equipment, materials, work times and precautions for work safety.

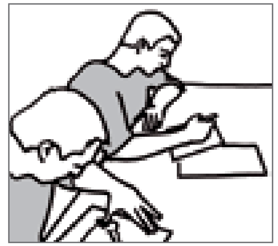


Fig. 223: Trainees creating drawings and work plans

Stage 4: The trainees manufacture their products

Referring to their individually drafted drawings and work plans, the trainees manufacture their bookshelves. First, they carry out preparations for their work by marking the materials according to the specifications on their drawings.

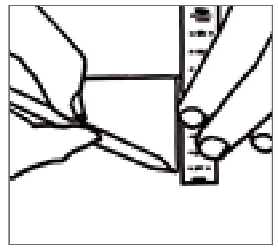


Fig. 224: Marking the materials

Next, the trainees start using the selected tools and hand-held machines.

If necessary, the trainer reminds the trainees of the work safety precautions, which they should already be familiar with.

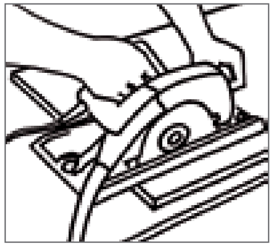


Fig. 225: Cutting the separate components of the bookshelf with a hand-held machine

Stage 5: Comparison and evaluation of the finished products

To conclude the practical project, the trainees compare and evaluate their finished products. They present their products and compare them with other trainees' products. Finally, the products are evaluated according to the previously established criteria.

The order of evaluation is:

- simple bookshelf with intermediate shelf
- bookshelf with intermediate shelf and rear panel
- bookshelf with intermediate shelf, rear panel and doors.

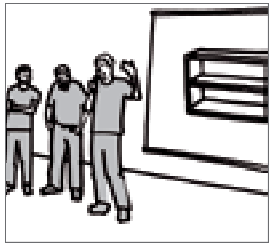


Fig. 226: Final presentation of products

3.12 Exercises and questions for review and consolidation

1. What is the trainee's main task during an apprenticeship?
2. What are the most important characteristics of an apprenticeship training?
3. Name the stages of the apprenticeship training!
4. What are the distinguishing features of the four-step method?
5. Please name the stages involved in the four-step method.
6. Please name the purpose of the first stage in the four-step method.
7. What kinds of ways are there of using the four-step method?
8. Please describe the type of implementation used for the four-step method.
9. How is the four-step method concluded?
10. What are the opportunities for practical learning provided by a short lecture?
11. Who can hold a short lecture during the lesson?
12. How should a short lecture be structured?
13. Name at least two advantages for practical learning that can be gained from a short lecture given by a trainee.
14. Please describe the procedure for a practical short lecture.
15. What learning objectives can be achieved by a short lecture given by
    a) the trainer?
    b) a trainee?
16. Please name the learning stages involved in a practical discussion.
17. What is the role of the trainees during a practical discussion?
18. What are the prerequisites in terms of content that trainees need to have for a practical discussion?
19. What kinds of skills can trainees acquire by taking part in a practical discussion?
20. Which practical operations is the work order processing method based on?
21. Please describe the stages of work order processing.
22. What are the characteristics of the work order processing method?

23. Please name at least three learning objectives that can be achieved by means of the work order processing method.
24. What is the significance of the experiment in a practical lesson and what are its characteristics?
25. What objectives can be fulfilled through a practical experiment?
26. Name the stages involved in the procedure for practical experiments.
27. Name at least three learning objectives that can be achieved by means of the practical experiment method.
28. What is the methodological principle behind training courses?
29. Please describe the five learning steps that make up the structure of a training course.
30. Which learning objectives can be achieved by means of a training course?
31. Why are the final evaluations so important for training courses?
32. Which didactic/methodological principles is the guiding-text method based on?
33. What are the characteristics of the guiding-text method?
34. Describe the sequence of the steps involved in a self-contained activity.
35. Please name at least four learning objectives that can be achieved by the guiding-text method.
36. Describe the sequence of the methodological implementation of a work task.
37. What are the characteristics of the work task as a practical method?
38. Name the learning objectives that can be achieved by means of the method of "work tasks".
39. What is the particular significance of the practical project?
40. Please describe the characteristics of a practical project.
41. Please describe the wider objectives that can be achieved by means of the practical project.
42. What are the five stages of a practical project?

4. Assessment of learning progress in practical lessons

Different ways for assessing learning progress have been widely used in practical lessons for some time. Some typical examples are the project task, the practical task or the practical test task. In addition to these, the most common types of progress checks are the single work sample and the integrated component. Both of these types of checks will be discussed in further detail below.

4.1 Single work sample

4.1.1 Basic principles for the organisation of work samples

Work samples serve as a representation of trainees' practical skills and a means of checking them.

By using work samples, the trainer can check a wide variety of learning achievements. For example, a work sample of work planning can be conducted by observing the complex processes of programming the controls for a machine.

Fig. 227: Observing machine control as part of a work sample

Another way of using work samples might be to focus on only one aspect of the completed work, such as the flatness of a given surface.

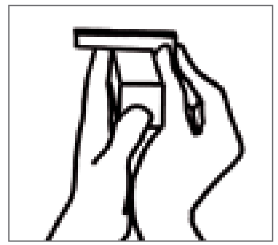


Fig. 228: Checking the surface quality by using the light-gap method

Alternatively, the work sample could be evaluated in terms of the accuracy of the dimensions.

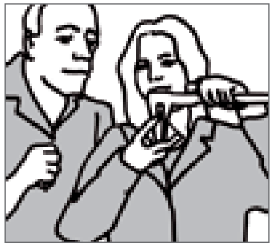


Fig. 229: Checking the accuracy of the dimensions of a work sample

The work sample must fulfil specific requirements, which the trainer should specify when explaining the work task. Some examples of these requirements are

- work accuracy (accuracy of dimensions, surface quality, cleanliness)
- amount of waste material produced
- number of working hours needed
- usefulness.

The main objective here is primarily to check trainees' manual skills – for example, processing material using hand-held tools. In most cases, personal abilities are also checked, such as perseverance, diligence, attention to detail or punctuality. If the task allows for a variety of possible answers, decision-making skills are also demanded.

Moreover, a work sample is also a means of checking procedural learning progress.

These include aspects such as the progress of the trainees' psychomotor skills during an activity – for example, when constructing a joint as part of woodworking.

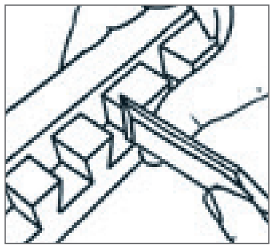


Fig. 230: Manufacturing a corner joint by hand

In addition, the correct use of tools or hand-held machines can also be checked. This also involves aspects such as work safety.

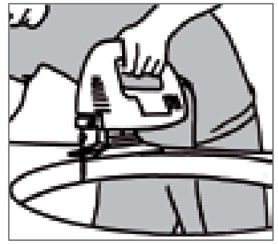


Fig. 231: Correct work technique with a jigsaw

Another aspect of a work sample that could be examined is the correct order and sequence of work steps. The organisation of the work steps can also be planned and evaluated as group work.

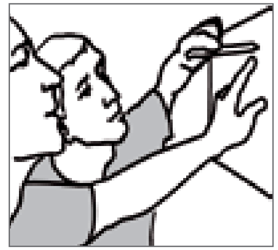


Fig. 232: Checking work planning

Work samples are frequently segments that are taken from a continuous sequence. They are literally conducted as representative "samples" that anticipate the execution of future activities using real tools or machines. These activities include tasks such as working on the spindle moulder, which - particularly from the point of view of work safety - can also be simulated in parts (mounting the safety guard, selecting settings and speed for machining materials, positioning of hands when machining).

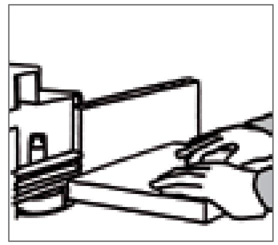


Fig. 233: Simulating the machining process

As a general rule:

The trainees must be given the exact criteria for the evaluation of a work sample in advance. As a rule, the task itself should also be described in detail and provided in advance.

The assessment of learning progress often takes place within the learning group, which means that when the task implementation time comes to an end, numerous products of the same type will have been produced. These can be evaluated according to the specified criteria, not only by the trainer but also by other trainees, who can compare and discuss one another's products.

Stage 1:
The trainer announces the task.

↓

Stage 2:
The class discusses the assessment criteria as a group. The trainer answers any questions.

↓

Stage 3:
The trainees set up their work benches and plan the implementation of the work sample.

↓

Stage 4:
The work sample is carried out. The examiner observes the proceedings.

↓

Stage 5:
The work sample is concluded. A final evaluation is performed.

Fig. 234: The process stages of a work sample

Assessment criteria	Work sample
Characteristics	*Work samples serve as means of* representing and checking practical skills. These can be made visible and verifiable by factors such as work accuracy, the amount of waste material, time taken to complete the work or the usefulness of the work product.
Learning objectives	The trainees will be able to - understand and follow a task. - carry out a verifiable task according to predetermined evaluation criteria. - demonstrate their technical skills and teamwork skills. - judge the significance of the work sample for their own learning process.
Procedure	- Announcement of the task. - Discussion of assessment criteria as a group and clarification of any questions. - Setting up of workbenches and planning of implementation by the trainees. - Implementation of work sample, alone or in a (small) group. - Conclusion and evaluation of the work sample.

Fig. 235: Procedure for a work sample – an overview

4.1.2 Sample lesson: work sample in the vocational field of "metalwork"

The task is to manufacture a nameplate using marking stamps and a metal plate. This work sample is primarily a means of checking the trainees' manual, psychomotor skills. Some of the ways in which these can be judged include the trainees' handling of tools, the accuracy of their work or the amount of time taken for the work.

In addition, personal behavioural dispositions can also be assessed, such as the trainees' diligence in work preparations and the work process, or even the tidiness of their workbenches.

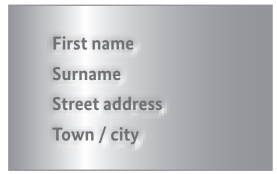


Fig. 236: Nameplate on a metal plate

The trainer informs the trainees of these evaluation criteria, and possibly also some others if necessary, before the commencement of the task and these are discussed.

After the task has been explained to them, the trainees ask questions. These questions are answered together as a class. The trainees then start work planning and preparing their workbenches. The steps involved in the implementation should be performed approximately as follows:

First, the trainees should measure the dimensions of the metal plate (100x50x1mm) with the steel scale.

The corners of the plate should be deburred with the flat file.

Markings should be scribed in two places, 5 mm away from the lower edge.

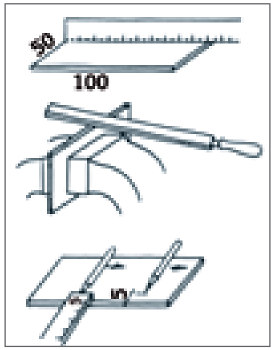


Fig. 237: Measuring, deburring and scribing

Using the steel scale and the scribing tool, the trainees scribe a line through the markings.

Next, 3 lines that are parallel to the lower edge should be scribed in the same manner, at a distance of 15 mm, 25 mm and 35 mm. The lower edge is the reference line for the measurements of 5, 15, 25 and 35 mm.

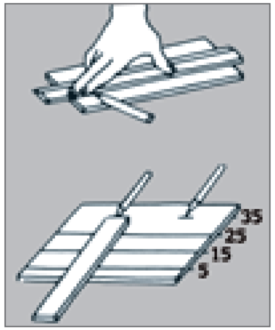


Fig. 238: Addition of markings and lines

Using the steel scale and the scribing tool, the trainees should mark a point 10 mm from the left edge.

The left edge is the reference edge for all vertical measurements on the plate.

The trainee must position the square ruler firmly at the lower reference edge. The marking should be completed on the left.

Next, a scribe line should be traced through the marking.

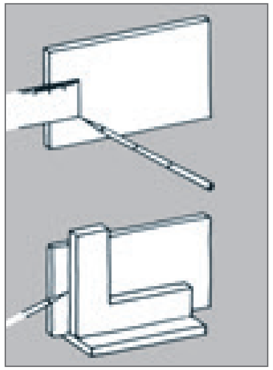


Fig. 239: Further marking and scribing steps

Finally, the name should be inscribed on the nameplate with the marking stamps.

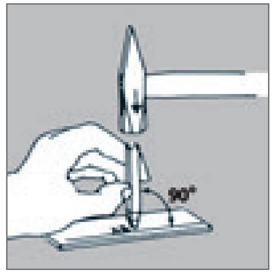


Fig. 240: Inscribing with a marking stamp

4.2 Assessment of learning progress through "integrated components"

4.2.1 Basic principles

In contrast to the work sample, the assessment of learning progress through "integrated components" is a multi-faceted method of assessing the trainees' vocational skills and abilities. Thematically, it is closely related to the practical project. Like the practical project, this method involves an integrated approach to a task. It draws on aspects of vocational knowledge and skills in a multi-faceted context.

The task for the trainees is typically to manufacture a specified component, including all of the required work stages. These include understanding the task, work planning and preparation, implementation of the work as well as checking and evaluation of the completed component. In addition, it is important that the trainees take these steps independently, taking responsibility themselves.

The first step is for the trainees to understand the task. The trainer must therefore inform the trainees of the evaluation criteria for the exercise and the test. At this stage, trainees may have questions, which they can discuss with other trainees or with the trainer.

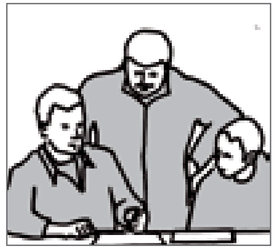


Fig. 241: Understanding the task

The trainees carry out work planning independently. They need to decide on the necessary materials, tools and machines (if applicable), the content and sequence of work steps as well as the necessary time frame. In addition, they need to consider aspects of work safety.

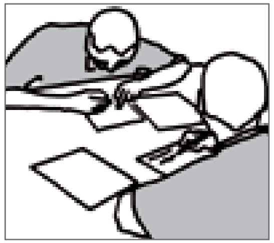


Fig. 242: Performing work planning

After completing their work planning, the trainees need to organise their workspaces. This is the prerequisite for a trouble-free, safe procedure of the work steps.

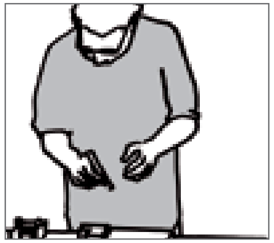


Fig. 243: Work preparations

Once the work planning and preparations have been completed correctly and carefully, the trainees should have no problem following the work steps in the planned order.

An assessment of learning progress of this type can also be implemented and evaluated cooperatively in a small group.

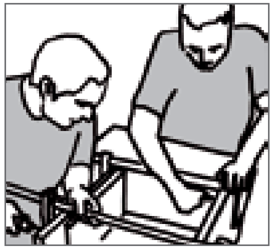


Fig. 244: Work implementation

After completing the work, the trainees check their finished product. In some cases it might be necessary for a trainee to make some further improvements on the work.

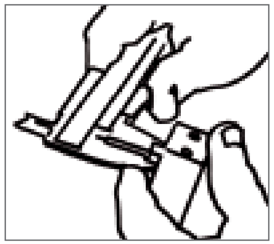


Fig. 245: Task checking

Finally, the trainees should reflect critically on the finished component and moreover, the work process as a whole. For example, the trainees might recall some of the successes or failures that they experienced while working on the task. They could then write down these experiences.

Another option would be a final evaluation session with the trainer, which would be a valuable means of recalling these experiences and discussing them as a group.

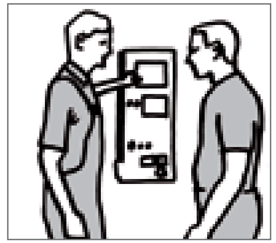


Fig. 246: Evaluation of the work

As a general rule:

The evaluation criteria for the integrated work task and test must be communicated to the trainees in advance. The task can be kept quite flexible, which differentiates this method from the work sample method. This promotes the trainees' decision-making skills.

As a general rule, the trainer performs the final evaluation of the completed components. The results of the evaluation are discussed as a group. Alternatively, the trainees themselves can also evaluate their own work. In this case, the trainees need to be informed of the procedure in advance.

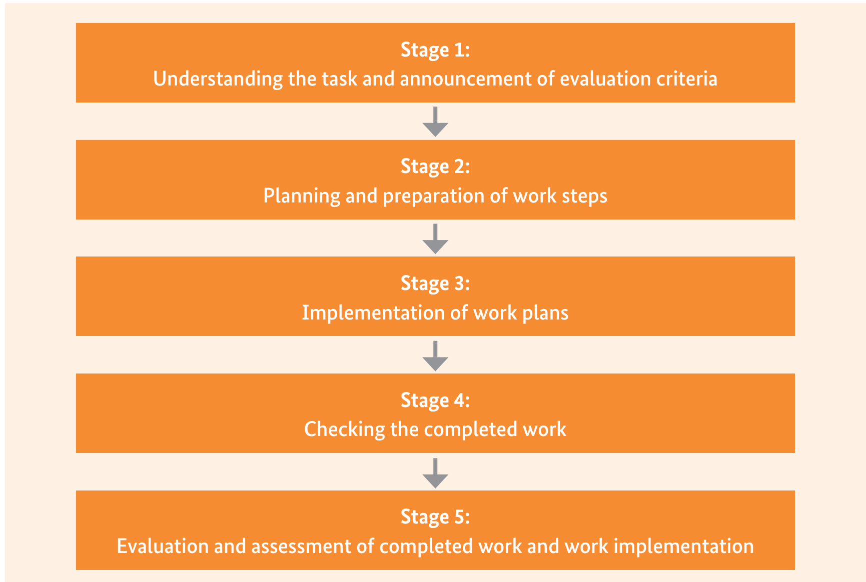


Fig. 247: Steps involved in the assessment of learning progress through "integrated components"

Assessment criteria	Assessment of learning progress through "integrated components"
Characteristics	The assessment of learning progress through "integrated components" is a multi-faceted approach to assessing a trainee's vocational abilities and skills. Thematically it is closely related to the practical project method. Likewise, it also involves an integrated task. It examines aspects of vocational knowledge and skills in a multi-faceted context.
Learning objectives	The trainees will be able to - plan and implement an integrated assessment of learning progress throughout all stages, - perform an integrated assessment of learning progress independently and cooperatively, - make their own decisions and support them with reasons, - independently evaluate their own work.
Procedure	- Understanding the task and announcement of evaluation criteria - Understanding and preparation of work steps - Independent implementation of work activities - Checking the completed work - Evaluation and assessment of the completed work and the implementation process

Fig. 248: Assessment of learning progress through "integrated components" – an overview

4.2.2 Sample lesson: integrated components in the vocational field of mechanical engineering

Stage 1: Task and assignment

Description of the assignment

This stage is the first step in preparation for the test. Before the actual exercise, the trainees are shown an assembled bending jig. The trainees examine the device and describe its function.

Fig. 249: The bending jig[3] shown to trainees

3 REFA: Methodenlehre des Arbeitsstudiums, Teil 6, Arbeitsunterweisung München 1975, P. 111.
The example of a "bending jig" was developed with the generous support of GUNT (Hamburg).

So that the trainees can identify how many separate parts the device has and understand its complexity, they are shown a drawing of the exploded view.

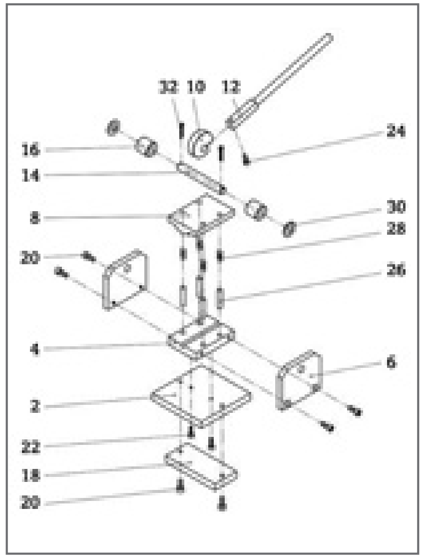


Fig. 250: Exploded view

Work assignment

As a test of their skills, the trainees are first given the task working in pairs to assemble a bending jig based on the available drawing and parts list. Then, to test the device, they are asked to bend a metal sheet.

The trainees are told that the evaluation is not just for the finished product. In other words, their work methods will also be observed throughout the task and evaluated. In addition, comprehension questions will be asked during the process.

The trainees read the assembly drawing and the detail drawings. They check the component parts for accuracy and completeness by referring to the parts list.

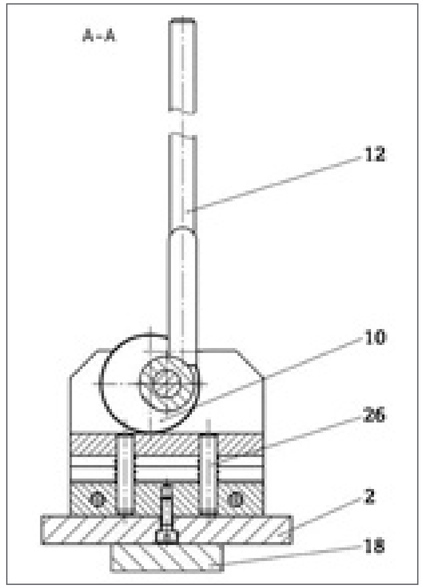


Fig. 251: View A – A

1 No.	2 Qty	3 Unit	4 Description
2	1	pcs	Base plate
4	1	pcs	Lower stamp
6	2	pcs	Side panel
8	1	pcs	Upper stamp
10	1	pcs	Eccentric
12	1	pcs	Lever
14	1	pcs	Axle
16	2	pcs	Spacer
18	1	pcs	Mounting plate
20	6	pcs	Cylinder screw
22	2	pcs	Cylinder screw
24	1	pcs	Cylinder screw
26	4	pcs	Cylinder pin
28	4	pcs	Spring
30	2	pcs	Washer
32	2	pcs	Splint

Fig. 252: Parts list

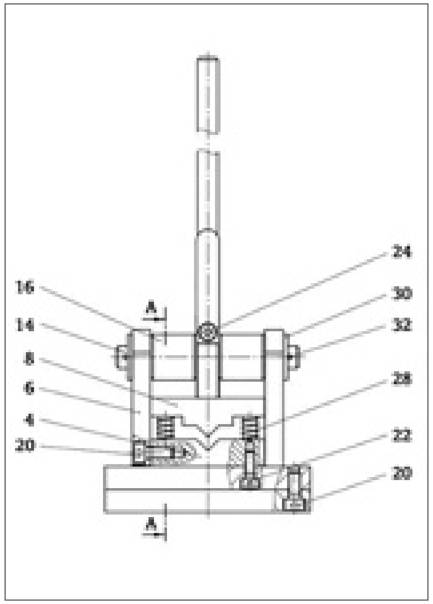


Fig. 253: View B – B

Stage 2: Planning preparation and work planning

The trainees decide with their partners which dimensions on the component parts are particularly important for the assembly and check the essential components, such as the “side panel”.

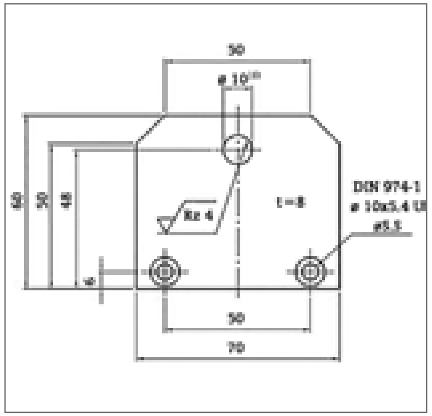


Fig. 254: Detail drawing of “side panel”

For example, when looking at the detail drawing for the “side panel”, they check the position and tolerance of the bore hole 10H7 with the control gauge.

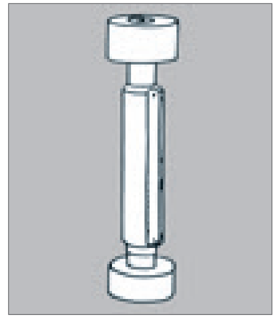


Fig. 255: Control gauge

To help them plan the assembly, the trainees create a structural drawing. The trainer observes their approach, the cooperation between the trainees during the process and evaluates their teamwork skills.

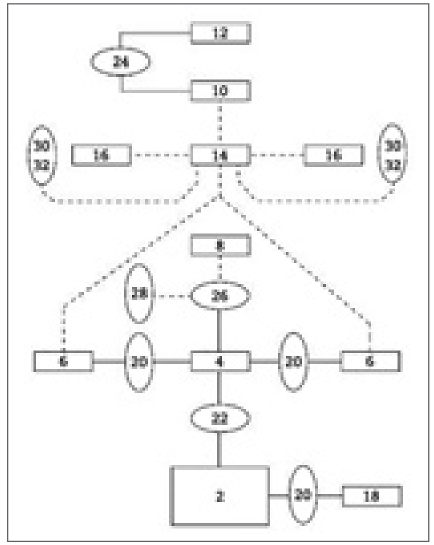


Fig. 256: Assembly plan – structural diagram

Also, the trainees create an assembly plan in the form of a table as an overview. Referring to their tables, the trainees select the appropriate tools.

Assembly plan for bending jig				
Assembly	Step	Part nos.	Process	Tools
Base plate	1	[illegible]	screw together	Hex key SW3
	2	[illegible]	screw together	Hex key SW4
Lower stamp	3	[illegible]	pin together	
	4	[illegible]	screw together	Hex key SW4
	5	[illegible]	interlock	
Axle	6	[illegible]	interlock	
	7	[illegible]	insert pin	
Exxentric	8	[illegible]	screw together	Hex key SW3

Fig. 257: Assembly plan for bending jig

Stage 3: Implementation of the work

After creating the assembly plan, the trainees start working on the assembly. During each work step in the process, the trainer observes the trainees and evaluates their technical and social skills.

First step: assembly of the base plate

First, trainees attach part 2 to part 4. Next, they attach part 18. If parts 2 and 18 are connected first, part 4 cannot be attached to part 2, because the counter-sinks for the screws (22) will be covered up.

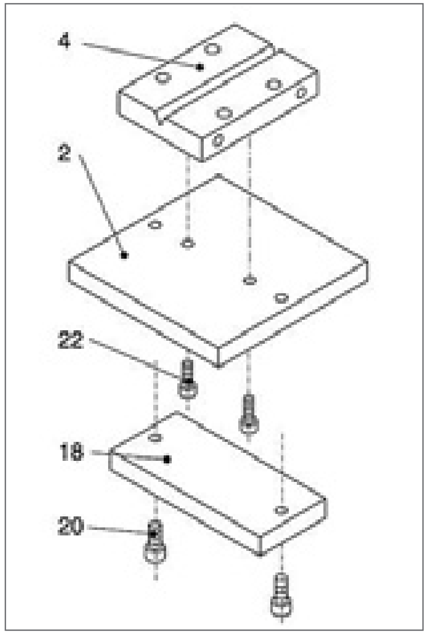


Fig. 258: Assembly of the baseplate

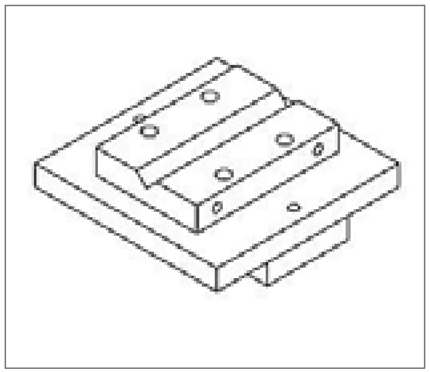


Fig. 259: Assembled baseplate

Second step: assembly of the lower stamp

Next, the trainees press in the pins (26). If necessary, they strike the pins lightly with a hammer to press them in. Then, the trainees connect the side panels (6) with screws. Finally, they install parts 28 and 8. The trainer watches the trainees to make sure that they apply an appropriate amount of force when using the hammer, not more than needed.

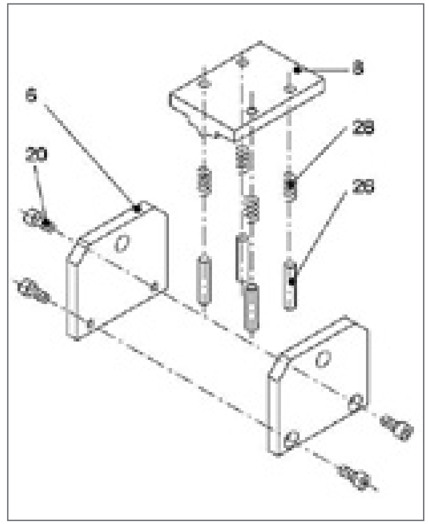


Fig. 260: Assembly of the lower stamp

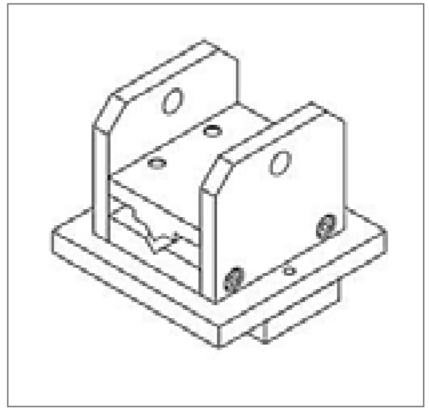


Fig. 261: Assembled lower stamp

Third step: assembly of the axle

The trainees connect all of the parts together. They install parts 10 and 16 at the same time as inserting the axle (14) into the side panels (6). Finally, they secure the axle through the standard parts 30 and 32.

The trainer observes the trainees, paying particular attention to their teamwork skills.

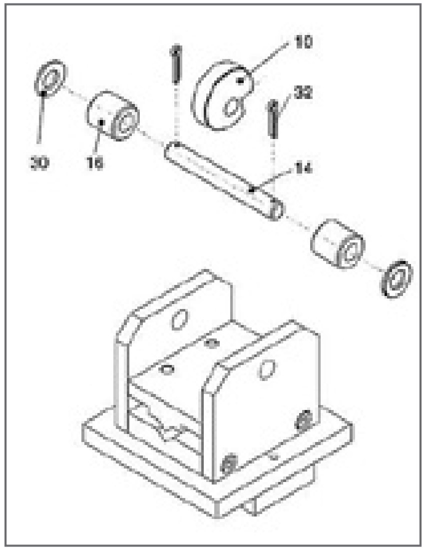


Fig. 262: Assembly of the axle

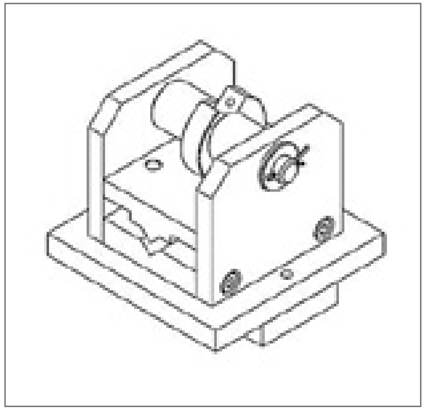


Fig. 263: The axle mounted on the lower stamp

Fourth step: installing the eccentric

The eccentric is already mounted on the axle. Trainees need only connect the lever (12) with the eccentric with a screw.

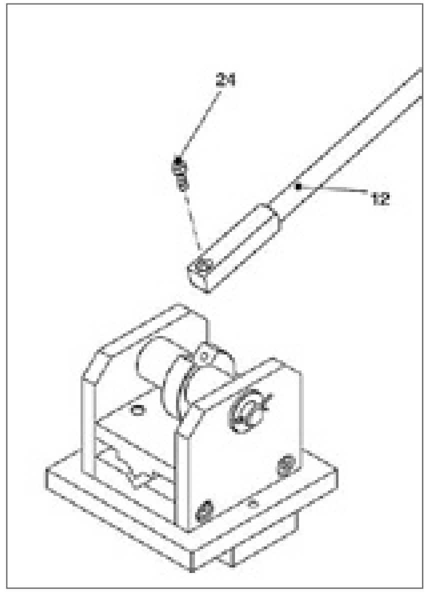


Fig. 264: Installing eccentric

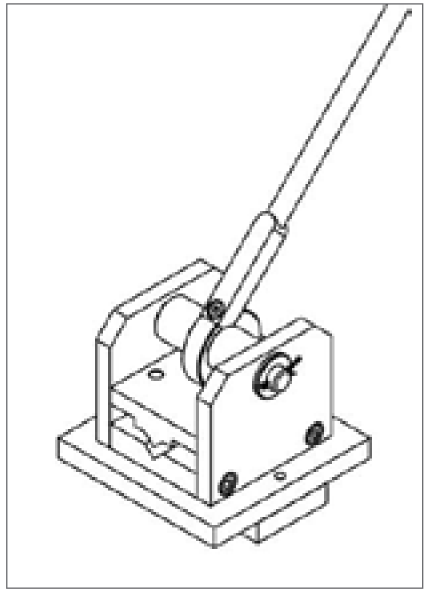


Fig. 265: Assembled bending jig

Stage 4: Checking the completed assembly

The trainees perform a check of their assembly and the completed product. Then they check the function of the device. The trainees use the bending jig to bend a piece of sheet metal and evaluate the results.

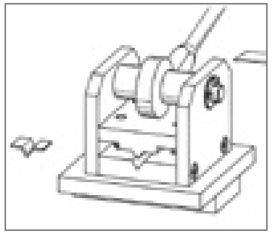


Fig. 266: Checking the function of the device

The trainer checks the effectivity of the device and notes the trainees' work approaches.

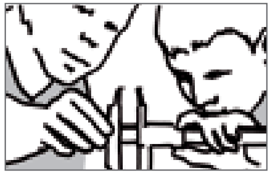


Fig. 267: Checking effectivity and approach

Stage 5: Evaluation

The trainer collects the finished bending jigs. The trainees are asked to give a self-evaluation of their own work approach, teamwork and the completed product.

Next, the trainer examines the functionality of each bending jig together with the trainees who assembled it. The trainer performs a visual inspection. When doing so, it is important to check for assembly mistakes or any minor damage that might have occurred during assembly.

Based on this protocol the trainer discusses and evaluates each individual's work approach in terms of technical and social skills. Last, the trainer gives trainees a final assessment in the form of a grade.

Fig. 268: Discussing evaluation

4.3 Exercises and questions for review and consolidation

1. What is the purpose of the assessment of learning progress using a “work sample”?
2. What practical results can be achieved through an assessment of learning progress in the form of a work sample?
3. How can the work sample be used to check whether or not the trainee has achieved general objectives?
4. In general, what activities are targeted by the practical assessment of learning progress using a “work sample”?
5. Please describe the stages involved in the work sample method.
6. Which criteria need to be taken into account during a comprehensive assessment of learning progress through “integrated components”?
7. Which stages are particularly important for an assessment of learning progress using “integrated components”?
8. What are the trainees told directly before the assessment of learning progress?
9. How are observations documented during a comprehensive assessment of learning progress?
10. What is the purpose of the practical discussions during an integrated assessment of learning progress?
11. How is the final evaluation for a comprehensive assessment of learning progress usually carried out?
12. Please describe some methods for final evaluations of comprehensive assessments of learning progress checks that involve participation by the trainees.

5. Practical didactics and methodology in an overall context

5.1 The practical relationship between vocational teaching and learning

Practice, it is often argued, develops by itself without any external effort, and therefore – it is further argued – there is no need for theoretical orientation in a practical lesson. Such arguments or similar ones are unacceptable and incorrect when judged by the criteria applied in vocational education.

There are now a variety of specific didactic concepts and also several methodological concepts for the practical lesson. However the manifestations of these are very different and there is room for improvement in many areas.

Practical lessons must be substantiated by theory-based didactics in the broader sense.

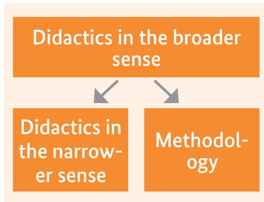


Fig. 269: Didactics in a broader / narrower sense

On this basis, trainers need to consider the decision areas of didactics in the narrower sense when planning each lesson. This applies to the decisions on the learning content as well as the learning objectives.

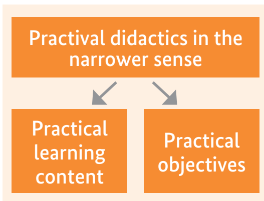


Fig. 270: Practical content and objectives

Likewise, trainers also need to consider the decision areas of methodology for each lesson, that is, the methods and media.

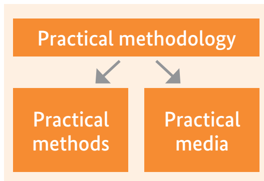


Fig. 271: Practical methods and media

Regardless of which decisions are made first when planning vocational training and lessons, all fields should be given equal consideration.

The interrelation between didactics and methodology must be balanced out. Therefore, making the decisions in each of the areas is a continuous process of adjustment.

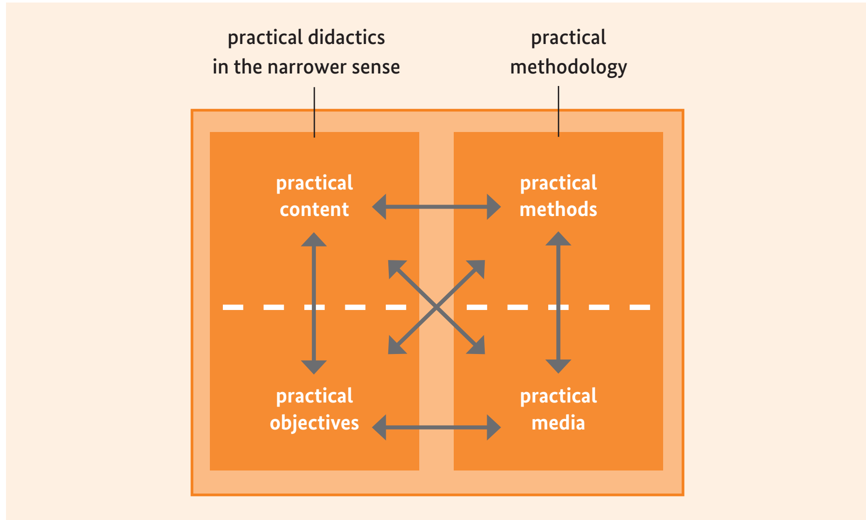


Fig. 272: Interrelation of decision areas

As a rule, the task of planning each lesson, particularly the practical lesson, takes place beyond the broad scope of scientific statements.

Although the content, objectives, methods and media have to be simplified for the practical lesson, it is still important to consider the interrelation between the decision areas and take a balanced approach.

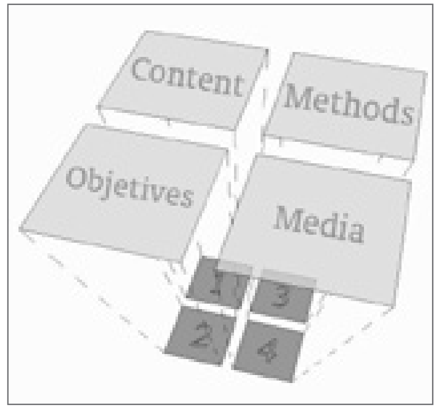


Fig. 273: Reduction of practical content (1), objectives (2), methods (3) and media (4) for lessons

When working on lesson procedures and planning the lesson, didactics and methodology should be viewed in a practical overall context. No decision area should be given priority.

In conclusion, we hope that the suggestions for the planning and implementation of practical lessons that are presented in this guide make the trainer's task easier.

Vocational trainers should, however, be aware that the concepts advanced here have been significantly simplified. Therefore, during the process of vocational teaching and learning the trainer should seek to continue the development of his or her own concepts of theory-based didactics and methodology, as well as the improvement of the lesson and the instruction. To do so, the trainer should also take note of reflections and afterthoughts on the learning process and document these.

For the vocational trainer, there is a lot to learn. The practical and theoretical concepts must be internalised. In addition, new concepts can even be created through the work of a committed trainer.

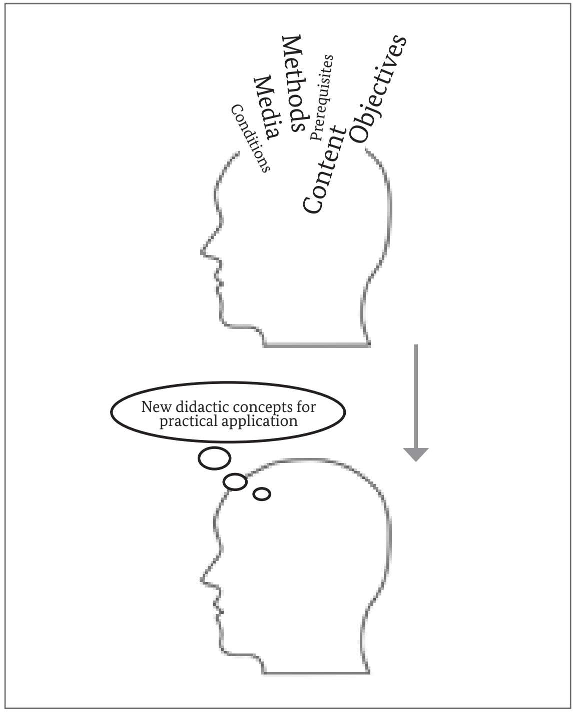


Fig. 274: Didactic elements and new practical didactic concepts

5.2 Exercises and questions for review and consolidation

1. How should we evaluate the assertion that a practical lesson should not be structured based on theory?
2. Please draw a diagram to illustrate the structure of didactics in the broader sense, showing how it is divided into didactics and methodology.
3. Please draw a diagram to illustrate the structure of didactics in the narrower sense that explains its division into two important categories.
4. Please draw a diagram to illustrate the structure of methodology, showing how it can be divided into two important categories.
5. Why must simplifications be made in all of the decision areas?
6. Practical lessons are generally beyond which scope?
7. What must be noted when viewing the decision areas of content, objectives, methods and media in an overall context?
8. How might systematic considerations for the improvement of the practical lesson be undertaken?

GLOSSARY

Important terms in vocational education for reference purposes; recommended literature and suggestions for further study as a guide for vocational trainers

I Initial conditions for practical vocational training based on societal conditions

Every society is faced with the task of passing on knowledge to the next generation, whether this concerns the physical world, the social order, the social norms for appropriate behaviour or finding one’s orientation in life. At the same time, this serves the concurrent purpose of the continuation of society as a whole so that those in the younger generation grow to become responsible, respected members of their community. In small, manageable communities, this happens incidentally, as children and teenagers grow into the culture and social order of their community in the course of everyday life. The more complex the society the greater the pressure becomes to organise the transfer of knowledge in a formal manner instead of leaving this to chance. As a rule, this happens over several decades with the development of a public school system.

The knowledge to be conveyed can be divided into the categories of science, morals and art. This can be organised into corresponding subjects: natural sciences, social sciences and art. Besides these subjects, the basic cultural techniques of reading, writing and arithmetic are taught systematically. The mastery of these cultural techniques is the prerequisite for the acquisition of cultural heritage. The acquisition of the cultural heritage occurs in formalised learning processes. In western societies, the learning process is referred to as education and the person who has completed this is considered educated.

This general pattern of transmission for bodies of knowledge and personal attitudes also applies to occupations. The informal sector in Afghanistan is an example of this. Young people enter a business as apprentices and acquire a range of verbally communicated knowledge and skills within a limited time frame. In this instance, we would describe this as vocational education or vocational qualification.

As a historical development, at least in Germany, the members of social classes who could afford an education financially were able to participate in educational processes.

Vocational training systems developed later. The targets of vocational education were young people from the classes who had to pursue paid work but did not have the financial means to participate freely in education. The state only took responsibility for this task because it was feared that social cohesion could be endangered. Social integration through the provision of vocational qualifications was the state’s answer to this potential threat. The fact that children from the upper social classes were able to receive an extensive general education whereas children from the lower classes received vocational training was seen as an expression of the inequality of general and vocational education. Along with social modernisation processes, there were also debates about the equality of general and vocational education. The two types of education are equal in terms of the entitlements that they provide when the course education is completed.

II General education and vocational training for the practice of work and technology

A distinction can be made between the content of general education and vocational education. The objective of general education is to produce a citizen who is judicious in both the private and the public spheres. The objective of vocational education is to produce a competent representative of the trade, a skilled worker.

The tradesperson is competent because he or she has mastered the skills of the trade and always knows what to do at any point in the work, when, in which order and why. This is only possible if the person has acquired the necessary background knowledge for the job. He or she must know the operating principles behind the machines and devices and also know how these operating principles can be adjusted and controlled according to various settings. Without this background knowledge, targeted and efficient work is not possible. In various countries, historical developments have resulted in the prioritisation of general education. At the same time, a systematic separation of education and vocational training developed. The consistent awarding of privileges to general education over vocational training has largely continued. Only through the work of vocational educationalists has vocational training been reevaluated.

When teaching practical lessons in the field of work and technology, the trainer should attempt to integrate the content of general educational lessons (such as reading and writing) into the practical lesson; for example, trainees could read work instructions and operation manuals, or write technical texts. This combines the need to convey additional new content or general educational content (such as language, methodological knowledge and social skills) as part of vocational training. This serves to counter any distinct divisions between general education and vocational training in vocational education courses.

Limiting practical training to practice only would be wrong. In a practical lesson the background and wider context is also important. The integrated communication of general and vocational content must be the goal of the vocational trainer. Irrespective of this, the difference between general education and vocational training has been becoming increasingly insignificant over the years, that is, general educational content is less likely to be awarded fundamental priority over vocational learning material.

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III Didactics of work and technology

The didactics of work and technology concerns the teaching and learning processes in the field of work and technology. The general didactics of work and technology encompasses technical vocational didactics or the didactics of technical vocational subjects such as metal technology, electrical engineering, construction technology etc., or alternatively it can refer to the general didactics of technology, which is a didactic comparison of the common aspects of technical fields.

The didactics of work and technology investigates and systematises the objectives and content dimension as well as the methods and media dimension of teaching and learning processes. Lessons and instruction are determined by the requirements for practical qualifications, and they have to respond to the needs of the trainees.

The qualification-oriented approach primarily targets the vocational qualifications for technical occupations. The task of didactics of work and technology is to demonstrate options for qualifications and improving practical training in companies and vocational schools. At the core of the didactics of work and technology is the didactic reduction to technical trades in practice. For systematic teaching and instruction, there are specific practical methods. However, wherever possible the educational requirements of the trainees should be taken into account through a personality-based approach and it is advisable to foster their ability to adapt to changing, continuous development arising from life and work situations dependent on work and technology.

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IV Didactics and the didactics for the practice of "work and technology"

Didactics is the link between the trainees and the subject of the lesson. By using didactics we can assess the trainees' level of progress and the extent of penetration of the logic of the content; we can also address educational objectives and apply the appropriate methodology to achieve them.

Vocational didactics in practice concerns theory-oriented vocational activities. This involves concrete recommendations for the practical lesson. The core of current didactics provides the orientation for abstract or concrete actions based on key themes of

- alignment of pedagogical action with key problems
- facilitation of key qualifications
- linking of working and learning
- learning at the work place
- design of work and technology

Key topics for the field of practice are

- the examination of work processes and social processes for the development of curricula based on the work process and the methods of developing these
- the reflection of action-oriented instruction and teaching methods and the utilisation of new media
- the contradiction between pedagogical objectives and company interests

It is particularly for the didactics of practical vocational education that there is the potential for a lack of background in lessons and a reduction of the content to pragmatic applications.

When planning and implementing the lesson, therefore, trainers should constantly reflect on and scrutinise the themes addressed by practical didactics.

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V Decision areas

The concept of "didactic decision areas" focuses on what is important for the trainer. The basic assumption of didactics is that the lesson must be preceded by a structural analysis that fully investigates the learning requirements. The objects of this analysis are six constants that the trainer must analyse before the lesson. These are the intention of the lesson, the subject, the methodology, the selection of media, the learning conditions and the social conditions. These constants are divided into decision areas and conditional areas.

The trainer must decide which intentions and objectives to pursue, what the subject of the lesson should be, and which media and which methods should be employed. These decision areas are interdependent. For example, some intentions can only be fulfilled by means of specific topics.

When making these decisions, the trainer is bound by specific conditions that cannot be changed. These are the anthropogenic characteristics that are inherent in the human species as well as the trainees' learning prerequisites. There are also sociocultural factors, such as the acquisition of gender roles, which are outside the trainer's scope of influence.

The field in which methodological decisions are made is very important. This is the area that involves decisions concerning the method and its implementation. In addition, it includes decisions about the media, teaching techniques, forms of action and social settings.

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VI Assessment of learning progress

Approaches in vocational educational theory focus on the greatest possible number of variations on the assessment of learning progress, because this gives the trainees the opportunity to demonstrate their proficiency across a wide range of knowledge, knowledge components and skills.

The characteristics of assessment of learning progress as aspects of practical training are that they

- are performed as real operational work assignments
- are dependent on an overall operational context
- make higher demands on independent action

Practical assessments of learning progress are aimed at trainees who already have some initial insights into the structures and contexts of operational work and business processes. Besides manual skills, they also have the ability to classify individual work activities within the context of an overall process and understand the significance of this for the overall business result. At first, progress checks involve single activities; later, they include more comprehensive knowledge of work planning or work organisation, covering aspects such as the planning of procedures and implementation of specific action sequences, the work safety regulations to pay attention to, the equipment to utilise, the principles of cooperation when working and the quality controls.

Assessments of learning progress of this kind are more comprehensive and require more extensive preparation, implementation and evaluation or follow-up measures than trainers are used to with work samples or single activities, which are often routine and independent of changing conditions that characterise work orders and manufacturing processes in a company. Instead, an assessment of learning progress based on processes in work and business focus on trainees' knowledge of typical content and structures. Moreover, they also examine additional skills such as the trainees' abilities to respond to specific task-related conditions or problems, that is, solve problems, make decisions and support them, as well as act constructively in work situations.

Assessments of learning progress as a part of the processes of work and business cover a wide variety of methods of testing practical learning progress. These include technical discussions, written processing of work assignments, or even a work sample. Learning progress checks must satisfy contradictory requirements. On one hand, the trainer must plan the learning process together with the trainees and establish a relationship based on trust. On the other, the trainer is obliged to evaluate the trainees' knowledge and performance, which undermines this position of trust.

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VII Learning objectives

Learning objectives prescribe the trainer's intended learning outcome for the trainees within the specified teaching and learning context. As this can clearly be traced to a particular course, from the trainer's point of view this also represents a teaching outcome. Formulations of learning objectives specify in normative terms what the trainees should be able to do at the end of the lesson that they were not able to do at the start of the lesson. The aim is therefore not to transfer every possible activity into formulations of learning objectives for a single lesson. Rather, learning objectives always focus on some kind of gain as a learning outcome. This can function on several different levels.

Learning objectives for the practical lesson should be formulated so that they are operational, that is, verifiable, wherever possible. Learning objectives can refer to a variety of different aspects, such as the cognitive, affective and psychomotoric dimensions of behaviour; or the aspects of competence such as technical, individual or social competence. When planning learning processes, it is essential to take the learning objectives into account as well as practical technical content, paying attention to the interaction between the initial learning conditions, the content and the methods.

It should be pointed out that an overly strong fixation on the learning objectives often seems to be more of a hindrance than a benefit for the lesson. This is equally true for vocational lesson content as well as general content. The approach has become more balanced as a result of the accumulation of practical teaching experience, as it has been established that on the one hand, too many learning objectives or those that are too finely differentiated and meticulously planned will force the lesson to become so restrictive so that it no longer centres around the learners; on the other hand, a lesson without clearly defined objectives is equally lacking in learner focus. Such a lesson can deny trainees opportunities for structured learning.

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VIII Content and selection of content

In the light of continuous technical and social change, the question of content and its selection, or where necessary, the exclusion of teaching and learning content in the field of technical didactics, is always current and relevant. For this selection process it is important to find practicable approaches to avoid the danger of being overwhelmed by the diversity and complexity of the subject, resulting in a complete incapacity to act. This is particularly true for the area of practical training.

Basically, when deciding on content, the trainer must also consider the trainees' situation and the trainees' interests. The selection of content must take the occupation into account and if possible the specialisations that are involved when seen in a larger context. For example, when teaching trainees about the electronic injection in a car engine, the trainer could include not only its structure and function, but also the problem of exhaust emissions, the necessary work adjustments that must be made and the significance of the regulations on carbon emissions with regard to their economic, ecological and medical consequences, which impacts the trainees' assessment of the value of responsible work behaviour.

The following specific didactic aspects should be considered when selecting content for a technical field:

- fundamental objectives in the field of work and technology
- selection of content with consideration for trainees' experience
- relevance of the subject for orientation in society, in the vocational field and in the specialised trade
- relevance of the learning content for the trainees at their future work places
- function of the subject for practical applications in actions during everyday work situations
- significance of the subject for practice in the technical field
- implementation opportunities for the learning content in training centres
- implementation opportunities for the subject based on its requirements with regard to classroom space and equipment
- selection of content with consideration of prevailing technical methods
- extent of motivation for the trainees provided by the learning content

By investigating the content of practical lessons from a complex, multi-faceted perspective that considers its significance for the trainees as well as the importance of continuing to examine further aspects of the subject, it is possible to shed light on a variety of developments and thus avoid narrowing down the subject to its more limited, immediately obvious aspects.

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IX Media and selection of media

The types of media that are characteristically significant for practical lessons include

- textbooks, catalogues or the internet
- tools, machines, equipment and work materials
- drawing materials
- posters, projectors or boards
- objects for demonstration or comparison purposes, such as technical devices or products

The selected equipment and media can be decisive for the practical lesson and partly or fully utilised throughout the duration of the course.

When organised and utilised in a flexible manner in learning processes, media and practical equipment can open up new possibilities in learning organisation and vocational didactics. For the stages in practical lessons that the trainees organise themselves, the range of media available needs to be as wide as possible.

The utilisation of work-oriented media calls for a significant effort in terms of organisation as well as safety-related preparation. The advantages of these real (workplace) media are that the trainees already have the opportunity during the training stage to use the devices to qualify themselves for their future jobs.

All media share the basic function of making vocational learning easier and more intensive, as well as increasing the trainees' motivation to learn. When selecting media for practical learning, priority should always be given to the form of representation that most closely resembles the real situation.

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X Methodology

In the field of vocational training, methodology is perceived as the theory of methods for lessons and classroom instruction. Methodology therefore includes both the organisation of methods by means of scientific analyses, and methods for the purpose of professional planning, realisation and evaluation of lessons and instruction. Methodology is the systematic study of the possibilities for promoting the organisation of learning and learning arrangements.

The field of methodology in vocational training is differentiated: in the core area, there are the actual *methods*, which belong to the arsenal of vocational training and are dealt with as a model for the arrangement of learning situations that encompass all methodological decisions, from the overall concept to the teaching techniques, tools and media.

Against the background of vocational fields of activity, there is practical methodology, which developed specialised methods and learning arrangements with regard to the establishment of special vocational, technical skills.

In order to distinguish between the different didactic ranges of methods, these have been divided into the subcategories of micro-methods, meso-methods and macro-methods. For example, stimuli, assignments and incentives belong to the subcategory of micro-methods. By way of contrast, training courses fall under the category of macro-methods.

A key area of methodology concerns the evaluation and systematisation of methods and methodological functions. Studies of the effects and efficiency of methods regarding the acquisition of skills by trainees serve to clarify the didactic position of methods. This knowledge is indispensable for goal-oriented methodological decisions.

Methodology also includes the function of developing and evaluating means and ways for teachers to acquire methodological competence, which is the main basis for professional didactic methodological activities in practice.

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XI Methods

Practical methods are the means by which learning objectives can be achieved. They determine how and to what extent the trainees' environmental conditions are interpreted as an incentive and opportunity for vocational learning or how the learning environment can provide stimuli and driving guidelines for vocational learning. The model used in a method concerns both the initial learning situation as well as the changes in the environmental conditions that come about in the process. The enhancement of learning by using media is always included as an option. The range of possibilities for the organisation of methods extends from learning environments that stimulate self-directed learning such as the project method, to those that result in externally controlled learning such as the lecture-style lesson.

When the trainer selects a method, such as the lecture-style lesson, or the four-step method for instruction, this will involve a network of separate decisions that refer to different aspects of learning environments and can be classified under the methodological decision areas.

For each method, there are six methodological decision levels for determining the organisation of the learning environment. These are:

- *Overall concepts* structure the fundamental intentions of the teaching and learning processes and the methodologically structured guidelines for the sequence of learning propositions or the changes in the learning situations
- *Action forms* determine the specific ways and extent to which these learning propositions are shaped based on the trainees' learning environment.
- *Social settings* concern the organisation of the personal environment and therefore fall under the category of communication and interaction between trainees and trainer.
- Through *articulation* changes in the learning environment are implemented in stages; the sequence of learning situations and events takes on the psychologically or theoretically founded procedure of the learning processes
- For *teaching techniques and tools* as individual methodological measures as well as
- *Media* the instrumental side of the method is expressed in particular. Through techniques and media, the learning environment can be organised in detail.

These decision levels each offer specific possibilities for the arrangement and variation of environmental conditions, in order to stimulate and promote learning in a particular way. This gives a method its orientation towards specific learning objectives or didactic position, which can be seen as the decisive criteria for a professional approach to method selection in the field of vocational training.

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XII Selection of methods

The implementation and selection of methods are the determining factors for the lesson. Trainers must make well-founded and well-considered decisions when selecting a method, as it has a major impact on the organisation of the lesson. Although bound by certain organisational constraints, vocational trainers make a largely autonomous decision on methodology. Other factors that must also be taken into account are the specifications of the curriculum, the trainees' requirements and the specific teaching and learning situation.

Methods that relate to specific types of work or subjects, which are important for a vocational field, should first be considered within an overall concept. This determines the selection of action forms, social settings, articulation, teaching techniques and media. It is undisputed that these methodological decision areas are interdependent. As an impetus for planning practical lessons, however, a pragmatic approach to vocational learning is useful. A more logical way of deciding on a method during the planning process would be to start on the level of macro-methods, and only later proceed to the meso-methods and micro-methods. This is because decisions in the area of macro-methods make up the foundation for a learning session or a whole sequence of sessions. On this foundation, further methodological decisions can be made to plan individual learning steps. Many decisions are in fact situational, that is, they are made during the actual lesson. The decision process on all methodological levels is determined by the following factors in particular:

- specified learning objectives, - the trainer's intentions
- learning conditions of trainees
- content-related decisions and other didactic concerns
- external possibilities of the learning environment and working environment.

Once a decision has been made about the macro-method for the learning session, the next step is to decide on the individual learning steps within a learning session on the meso and micro levels, which feed back in to the macro-method.

There has long been general consensus that a micro-methodological approach does not always have to be preceded by lesson planning. Particularly micro-methodological decisions and activities often take place on a short-term, situational basis, whereby the trainers can draw on their arsenal of methods based on experience and routine

application. Here too, the trainer's knowledge of the possibilities and limitations of the micro-method play a significant role in the decision.

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XIII Change of method

Trainers are advised to change their form of conveying knowledge, at the latest when the learning process has been sustainably impaired or interrupted. Which approach to choose depends on the trainer's personal repertoire of methods, among other things.

For practical lessons, the methodological change might take place on the macro-level, but this could extend to changes on the meso level and micro level as well.

The current definition of the macro level includes communication processes that have an extensive didactic range and can cover anything from a coherent learning plan to a complete learning situation. However, occasionally it is beneficial to change to another macro-method during the lesson. On the meso and micro levels, there are a great variety of methods to fall back on to replace the current methodological procedures in a lesson with an approach that is

- learner-centred
- awakens the learner's interest
- supports learner independence
- provides motivation

Particularly on the meso and micro levels, changing the method has been becoming increasingly significant as a factor in shaping learning progress. This applies to both the individual and groups in which the weaker learners are encouraged rather than left behind and the stronger learners arrive at the intended objective more quickly and can be motivated by additional tasks. The implementation of different methodological procedures for individual learners is one type of differentiation within a group that demands thorough observation of individual learners as well as the entire group. Here it is important to identify difficult passages throughout the course of the learning process, assess the learner's learning opportunities accurately, select methods that are appropriate for each learner and allow for methodological changes. In a larger communication project, a certain method might be appropriate for one trainee, but another method might suit another trainee. In both cases, the trainer should strive to ensure that the trainees are able to independently obtain most of the knowledge needed for skilled working in a trade. Therefore the trainer needs to pay attention to the difficulty of the work tasks as well as the extent of the trainee's prior knowledge and vocational experience. The decision on a methodological change must frequently be made under the pressure of limited time in the middle of the learning process and

can only be partially organised when planning in advance. Changing the method during the learning process is a particularly challenging task for the trainer which demands considerable pedagogical skill.

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Jung, H.; Pahl, J.-P.; Schröder, W. (1999): Fachpraxis Metall für die berufliche Aus- und Weiterbildung, Cornelsen Verlag, Berlin und
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Imprint

Published by
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn und Eschborn

Promotion of Technical and Vocational Education and Training (TVET)
Qala-e-Fatullah 6, Taimani Road, Kabul / Afghanistan

Responsible
Gustav Reier, Kabul

Authors
Franz Ferdinand Mersch, Hamburg, Jörg-Peter Pahl, Hamburg und Dresden

Design
MediaCompany – Agentur für Kommunikation GmbH, Bonn

Printed by
Druckriegel GmbH, Frankfurt am Main

Cover photo
GIZ Afghanistan

Graphics:
Franz Ferdinand Mersch
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As at
Mannheim, 2016

ISBN: 978-3-944152-51-6

GIZ is responsible for the content of this publication

On behalf of
Federal Ministry for Economic Cooperation and Development (BMZ)
Public relations, education and information

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