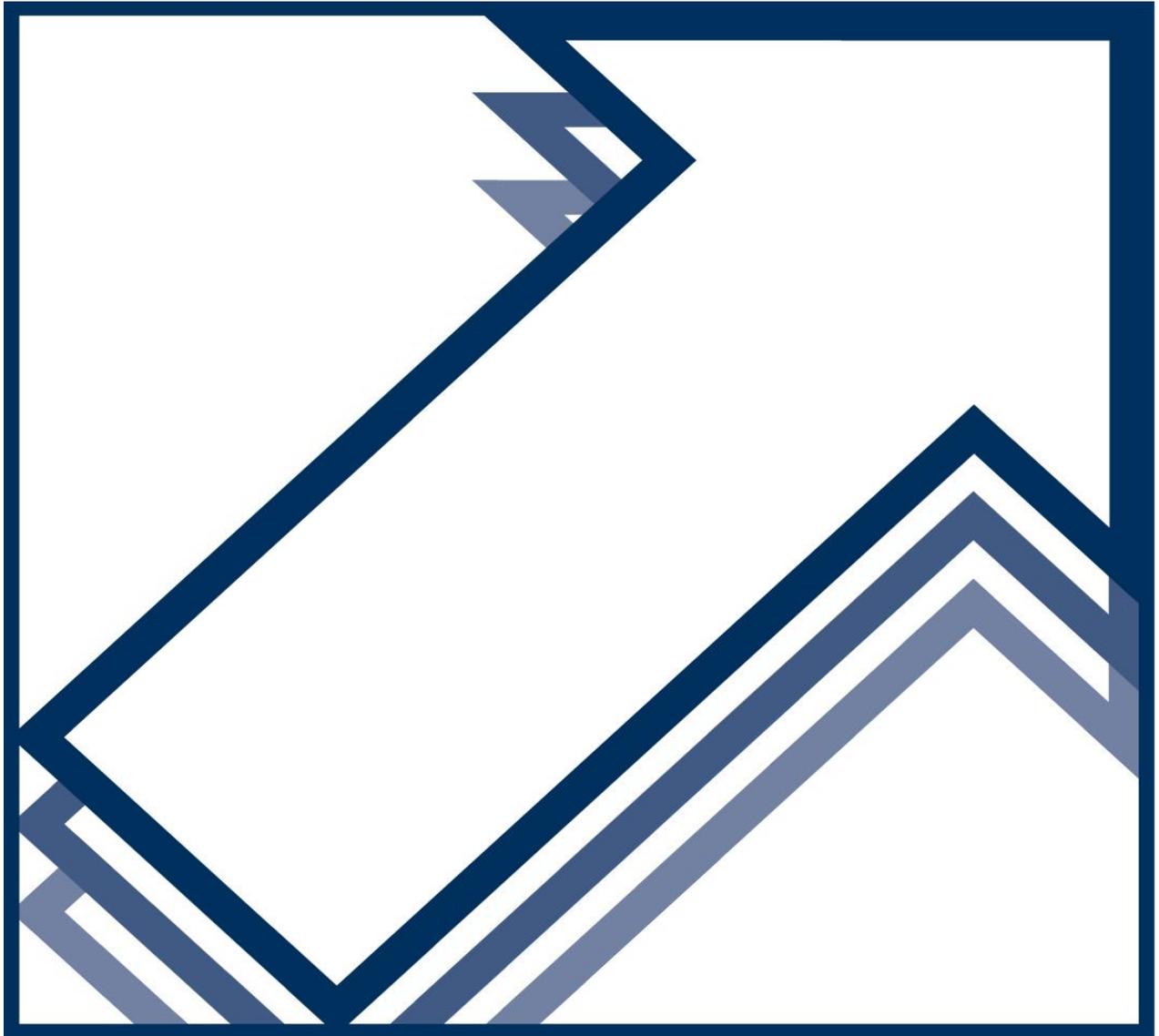


Hanno Hortsch, Steffen Kersten

Didactics of Vocational Education and Training



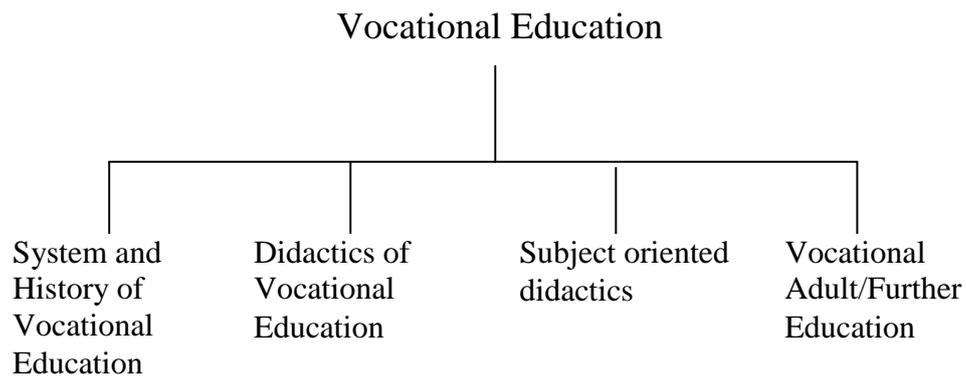
Study Material

Dresden/Beijing 2022

Structure of the Lecture
“Didactic of Vocational Education”

1	INTRODUCTION TO DIDACTICS OF VOCATIONAL AND FURTHER EDUCATION	3
2	BASIC DIDACTIC CONCEPTS OF THE PRESENT	4
3	NATURE OF THE PROCESS OF VOCATIONAL AND FURTHER EDUCATION FROM A DIDACTIC POINT OF VIEW	8
	<i>Seminar 1: Lesson planning in Vocational Education Basend on Act Theory</i>	<i>8</i>
4	DIDACTIC PRINCIPLES IN THE PROCESS OF VOCATIONAL AND FURTHER EDUCATION	24
	<i>Seminar 2: Didactic principles</i>	<i>24</i>
5	DIDACTIC ELEMENTS OF THE VOCATIONAL AND FURTHER EDUCATION PROCESS	34
5.1	Forms of Organization in the Vocational and Further Education Process	34
	<i>Seminar 3: Didactic-methodical Elements in the Design of Vocational Education – forms of organization -</i>	<i>34</i>
	<i>Seminar 4: Form of Organization of vocational teaching practising teacher talk</i>	<i>36</i>
5.2	Didactic Intentions and didactic function	42
	<i>Seminar 5: Control and evaluation/assessment of learning efficiency</i>	<i>48</i>
5.3	Teaching Methods	51
	<i>Seminar 6: Teaching methods according to Erkenntniswegstrukturen (structures of paths of cognition)</i>	<i>51</i>
	<i>Seminar 7: Practising teaching methods</i>	<i>57</i>
 APPENDIX		
	Steffen Kersten: Approaches of Engineering Pedagogy to Improve the Quality of Teaching in Engineering Education.	67

1 Introduction to Didactics of Vocational and Further Education



The **Object of Didactics of Vocational and Further Education** is the Process of developing professional/vocational decision-making and responsibility.

The **Content of Didactics of Vocational and Further Education** is the lawful coherence of the design of the development process of decision-making and responsibility at different learning locations from a vocational and/or multidisciplinary point of view.

2 Basic Didactic Concepts of the Present

"Normative Didaktik"

[Normative Didactics]

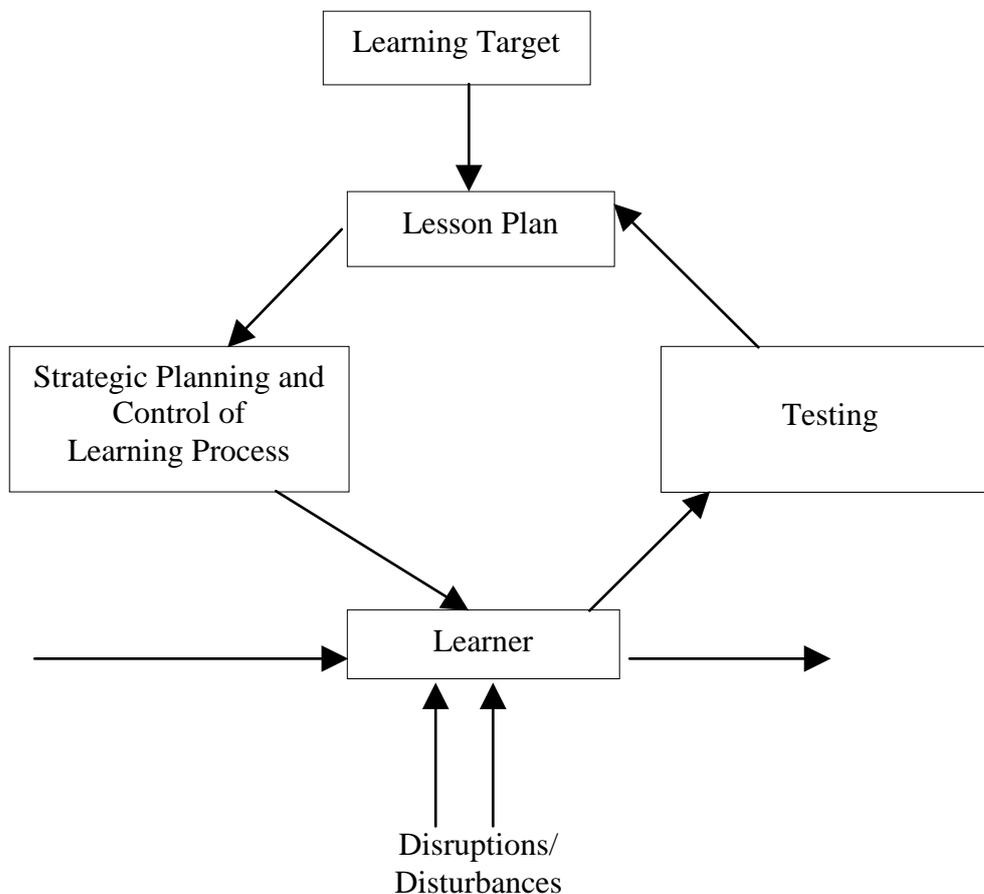
...a system based on the concept of utmost pre-pedagogical sense-norms on, human life, the position of man in the world or the nature of man. All contents of the lessons as well as the curriculum are based on education norms which are derived from these sense-norms. It goes on differentiating methods and ways of education, creating a closed conclusion chain (Deduktionskette) which states how the reality of "Lessons" should be.

(Compare: BLANKERTZ, H.: Theorien und Modelle der Didaktik, München 1969)

Informationstheoretische Didaktik

[Didactic Model based on Information Theory/ Theory of Communication (control cycle model)]

(v. CUBE)



Bildungstheoretische Didaktik

Starting point for the formation of pedagogical theories is the reality of education/
upbringing

Concept formations occur in contact with practical side of education and its interactions

"Education" (reality, not theory) is seen as the key category.

Conclusions

- Contents must be suitable for self-realisation and for the formation of maturity of the learners.
- Vocational Education should be seen from the aspect of learning contents useful on the job.

Lerntheoretische Didaktik"

(HEIMANN, SCHULZ)

Berlin Model (HEIMANN)

Lessons/teaching can be described via fields of conditions and fields of decision.

Fields of Conditions:

1. Anthropogenic pre-conditions
2. Social and cultural pre-conditions

Fields of Decision:

1. Intentions
2. Content
3. Methodology
4. Choice of media

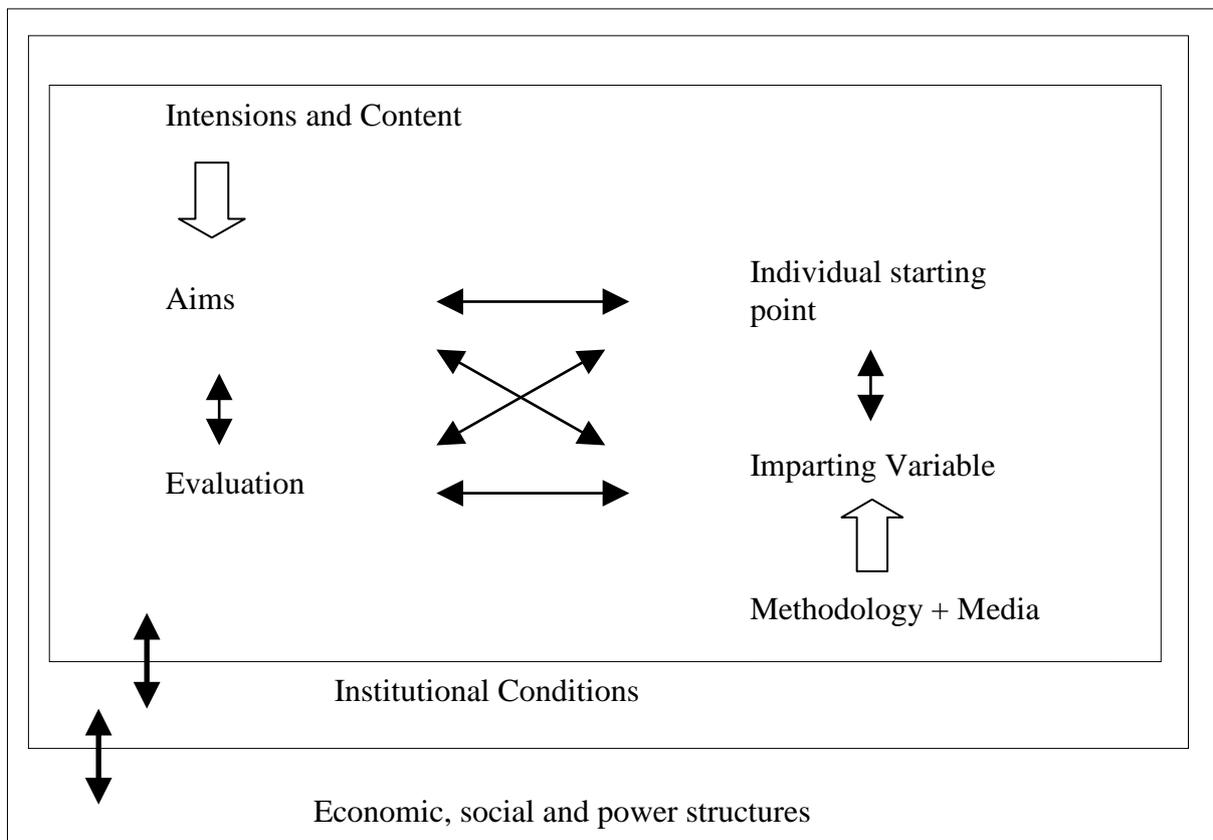
Lesson analysis goes from fields of decision to fields of conditions.

Lesson planning emanates from the fields of conditions.

Principles of Lesson planning:

- Interdependency
- Variability
- Controllability(in terms of Evaluation)

Outline Plan according to the Hamburg Model (SCHULZ)



Tasks

1. Discuss didactic considerations/reflections and intentions, that go with the term "Development/evolution of personality/identity of the learner".
2. Which kind of practical consequences arise from the approach of "Lerntheoretische Didaktik" (by HEIMANN, SCHULZ) for the teacher when planning lessons?
3. Discuss the following statement:
"The learner is both object and subject of the lessons at the same time."

3 Nature of the Process of Vocational and Further Education from a Didactic Point of View

Seminar 1: Lesson planning in Vocational Education Based on Act Theory

In the seminar we will discuss consequences for a concept for vocational lesson planning, starting from findings in developmental psychology and in theory of action. These theses for the characterisation of lesson planning in vocational education based on act theory will be developed and discussed referring to the theories of HERING, HACKER, AEBLI, GUDJONS and MEYER.

Tasks

1. Prove the following hypothesis:
Lesson planning based on act theory is oriented at the needs of the learners.
2. Exemplify how you would ensure a complete processes of acquisition in your lessons.
3. Which are the components of "professional/vocational decision-making and responsibility"? Illustrate the resulting consequences for lesson design.
4. Rebut the following hypothesis:
In lessons there is a subject-subject-relation between teacher and learner.
5. Why are the processes in education so complex? Discuss the consequences for lesson planning and lesson preparation arising from this complexity.
6. Discuss the relationship of "planned learning acts" and "compensation acts" of learners.
7. Discuss the term "object of acquisition"!

Taylorism versus Lean Production

Two key features of Taylorism

- ...
- The workforce within the meaning of the company, ie for the appropriate work tasks, training and further training. Through training of the workforce to maximize performing procedures to be achieved.
- By, large-scale division of labor, the cognitive demands on workers are kept at low level, to shorten the training period of the workforce.
- ...

(Taylor, F. W.: Die Grundsätze wissenschaftlicher Betriebsführung. München, Oldenbourg, 1913)

Main Characteristics of Lean Production related to VoCEd:

- Reduced use of staff

- Low stock (-> related to „Just in Time“)
- Shorter development times
- Lower capital investment
- well-trained or educated staff
- Social bond for the staff of the company

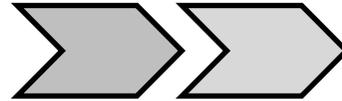
Working Process



Qualifications

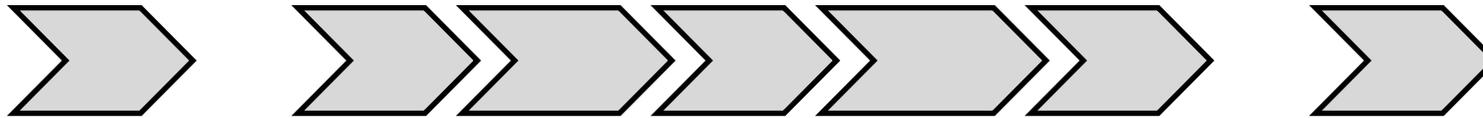
Networking:

- Production/Services
- IT-Systems



Interfaces:

- upstream and downstream areas
- external and internal customers



Quality Assurance:

- Products/Process
- Q-Documentation

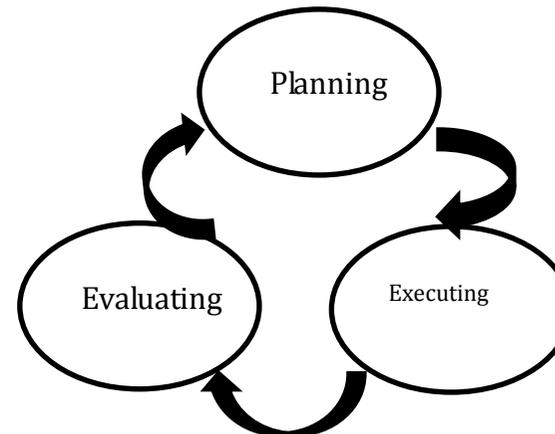
Labour

Organisation:

- Cooperation
- Communication

System competence:

- Function, Linkages
- Integration



Components of the Structures of Modern Production Relevant for Education

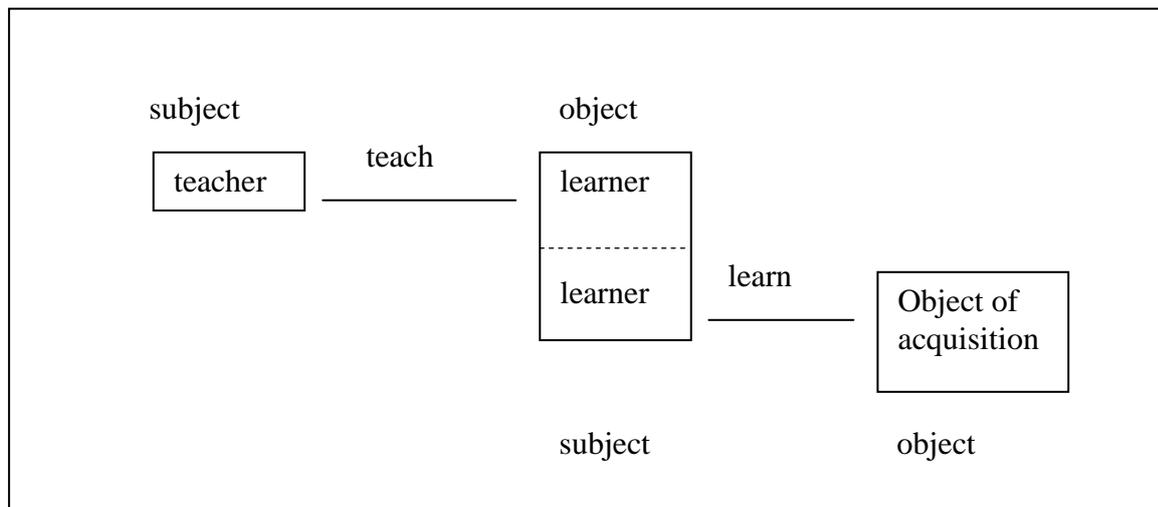
1. Process chain oriented company organisation instead of functional hierarchies
2. Customer oriented instead of product oriented
3. Responsibility for the project/venture and budget instead of hierarchically structured task management
4. Working in teams or groups instead of working alone
5. Complete operations instead of individual/single acts
6. Self-regulation instead of standardised input/guidelines
7. Involvement instead of heteronomy
8. Continuous improvement instead of hope for innovation

(compare FRIELING, E., Personalentwicklung und Qualifizierung.- Hochheim, 1993, S. 32)

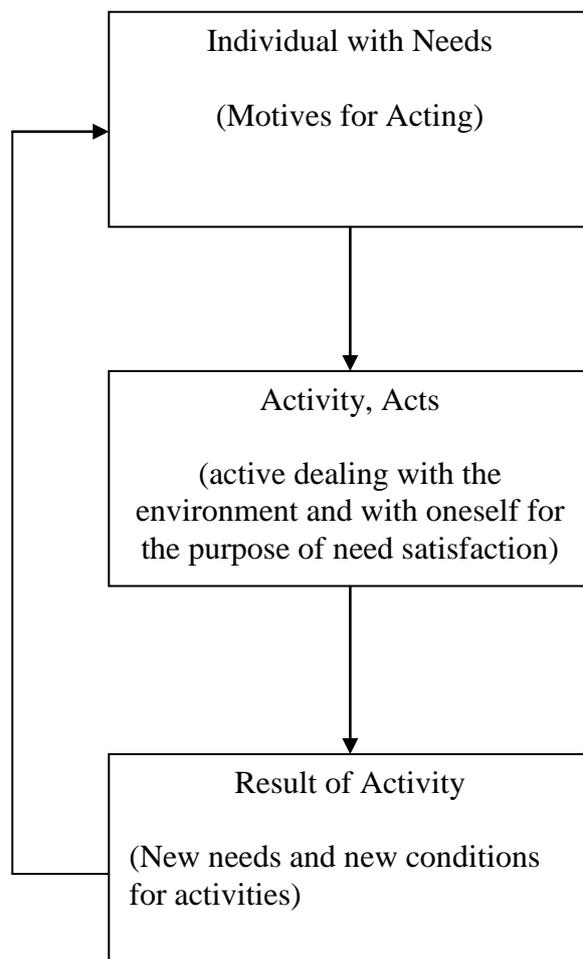
Initial Considerations

1. The process of vocational and further education has a dual character concerning its essence and comporment.
On the one hand structural and/or functional catenations exist, which comply with organising principles; on the other hand, its systems are chaotic.
2. For the process of vocational and further education this means that the dynamic successiveness of states of its systems are deterministic, stochastic and chaotic.
3. If the process is to be described, both the external conditions that influence it, and the internal conditions that work inside the process itself have to be described. (compare Lerntheoretische Didaktik!)

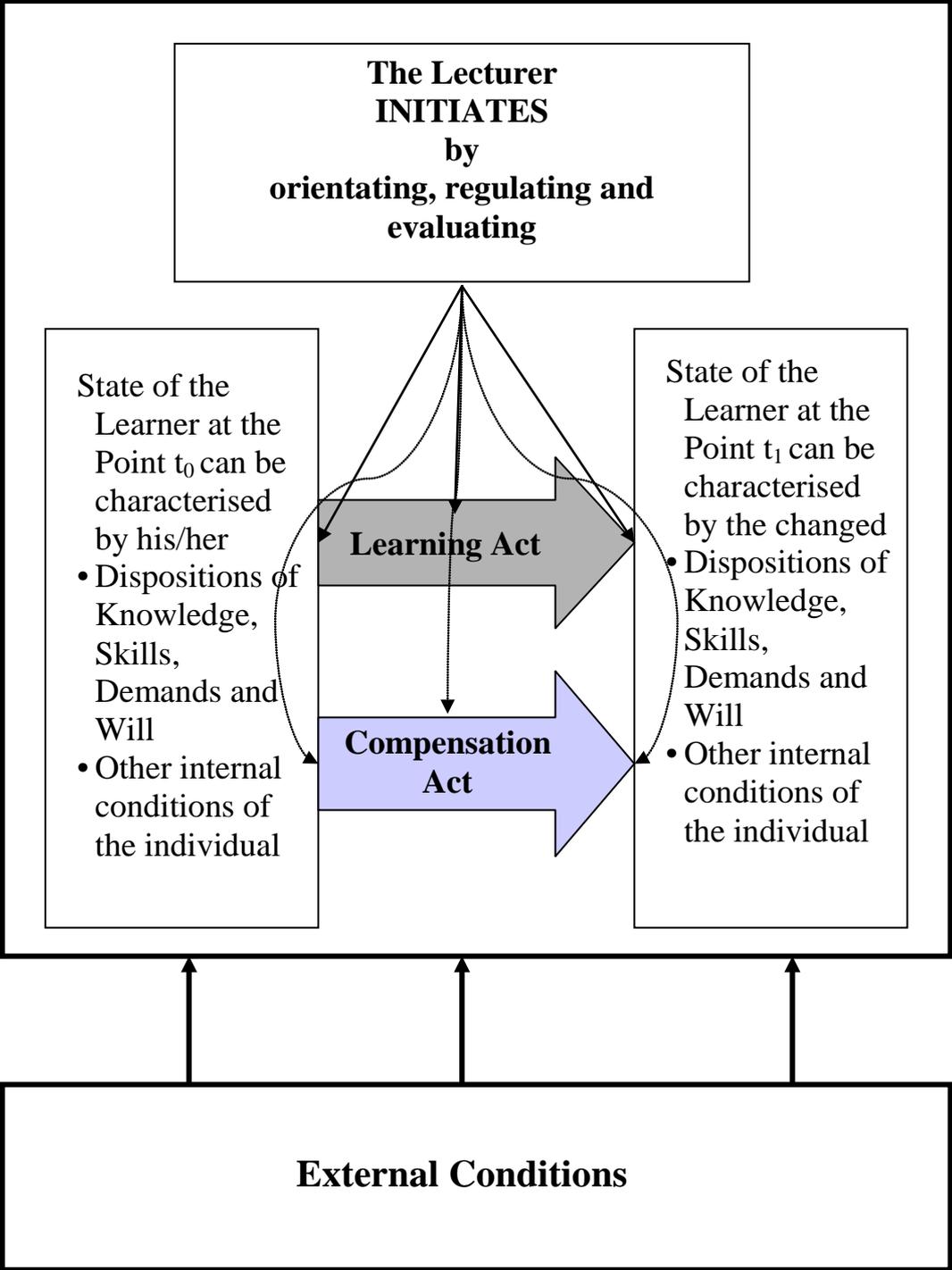
Basic didactic relationships



Act as a process of feedback



Simplified Model of Education



Matters of acquisition

descriptive matters of acquisition

- terms
- statements
- theories
- hypotheses
- ...

regulative matters of acquisition

- rules
- methods
- algorithms
- principles
- ...

normative matters of acquisition

- norms/standards
- fiats/commandments
- orders/instructions
- ...

Personality features (PF)

- knowledge
- insights
- skills
- abilities
- attitudes/mindset
- convictions/opinions
- attitudes
- ...

Qualification

as a disposition of personality features oriented/aimed at professional/vocational activities

Multifunctional key abilities reconstruct and construct functions and PF in acts

Functions of personality features in activities

Knowledge

- informative pre-condition for professional/vocational act

Skill

- subjective possibility for professional/vocational act

Volitional Disposition

- subjective necessity for professional/vocational act

Forms of behaviour

Output

as result of

behaviour/
conduct

on the basis of existing abilities for vocational/professional "Handlungskompetenz"

STRUCTURES

Fixed societal structures
of knowledge

Non-intensional complex structures
as an individually organised effigy
of reality

Intension related complex
structures as an individually
organised effigy of the demands in
a situation

Controlled/regulated in individual
situations complex structures as an
effigy of the organisation of
activities adjusted to individual
situations

Processes



Acquisition of Knowledge

Functionalised Knowledge

Application of Knowledge

predominantly as

predominantly as

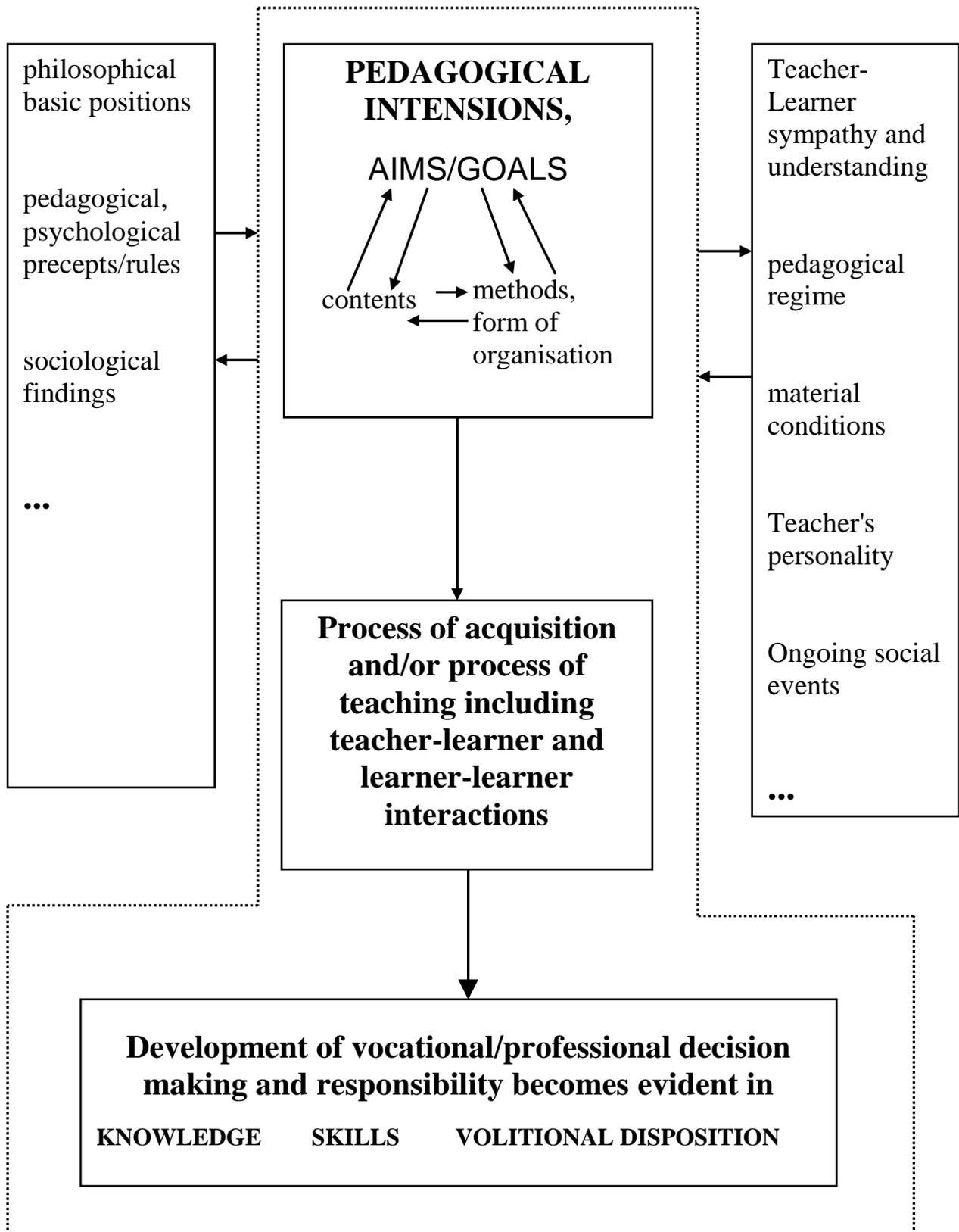
predominantly as

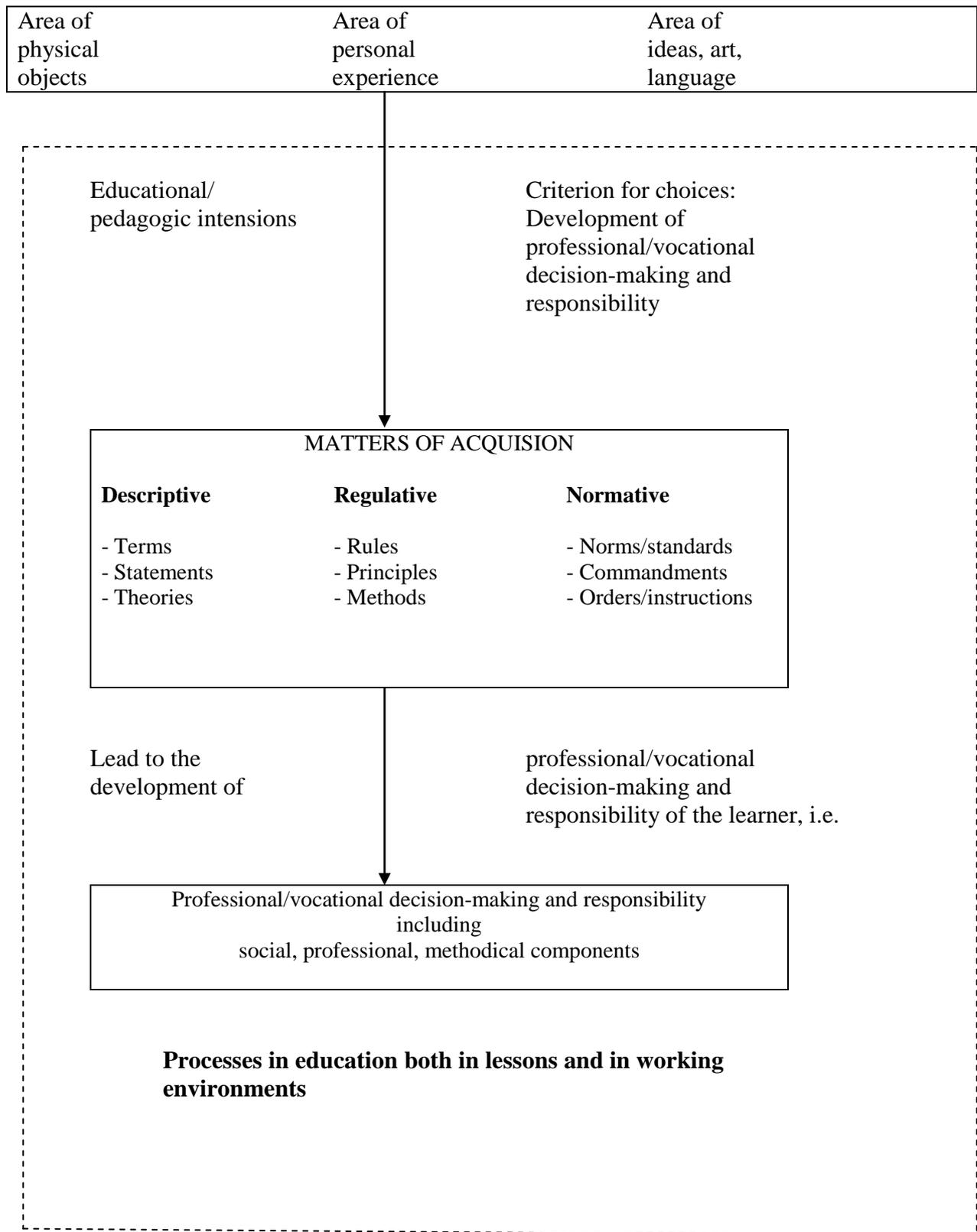
Construction

Reconstruction

Transformation

Components of the development of professional/vocational decision-making and responsibility





Conclusions

1. The learner acts actively, precise, future-oriented and creative on the lesson, is involved in its design and influences its structure.
2. The learner tries to reach his/her own goals or set goals by acting, either independent or together with others.
3. The acts of teacher and learners are a complex as the external conditions affecting the process of vocational and further education. The stability of this process held up in equal measure by both order and chaos.
4. An important principle of organisation:
Lessons are organised on the basis of acts of teachers and learners.
The teacher initialises acts by orientating, regulating and evaluating.
5. Lessons based on act theory is to be characterises/distinguished among others by the following relations
 - a) Relation of object/aim-means-content
 - b) Relation of organisation of teaching and learning
 - c) Relation of interactions
6. The impulse for the accomplishment of learning acts consists in the antagonism of continually increasing demands on the learner, initiated by the teacher, and the current state of the learners knowledge, skills and will.

Clarification of a number of important terms

Qualification: Disposition of personal features/attributes/qualities aligned at certain vocational activities.

Professional/vocational "Handlungskompetenz": Ability of displaying responsibility in regard to professional/vocational activity and of making qualification functional.

Components of professional/vocational decision-making and responsibility

Factual Component: The informative precondition of professional/vocational activity.

Methodic Component: Subjective possibility for acting is aimed at this component. It also comprises the finding of the possibilities.

Social Component: It puts forth subjective necessity for the activity. This includes, among other things, the evaluation of social relationships.

HABERMAS (Theory of Communication Acts. 1981, Bd. 1)

differentiates between *subject-matter related actions or instrumental actions* (f.i. maintenance of a car) and *social actions* (f.i. coordination on procedure of actions).

Social actions can be divided in:

- Strategic actions
- success related actions

Social Actions

„Social action ... indicates such an action that according to the acting person's intended meaning or the intended meaning is related to the behavior of other individuals and their actions performances.“ (Weber)



Social actions are communicative actions and based on interaction.

Theses for identifying instruction based on Act Theory (ebAT)

1. **ebAT** is not a method but an **approach** for the planning of the learning process. It is open for all scopes for design of organised learning processes.
2. **ebAT** puts the learner in the centre of the lesson as an acting individual that shapes learning processes widely **self-determined, active** and **reflective** and that is able to make independent decisions concerning alternatives for aims, ways and media of learning acts.
3. **ebAT** is predominantly characterised by self-determined learning. The teacher's role changes from dominant instructor to the learner's partner who assists them with learning aids. The teacher initiates learning by orientating, where necessary regulating and evaluating.
4. Designing learning processes in **ebAT** means **creating learning conditions** in particular, which facilitate intended relationships between the learner and the matter of acquisition.
5. **ebAT** is predominantly based on **self-controlled learning**.
6. **ebAT** aims at the formation of **professional, methodical** and **social components of "Handlungskompetenz"** (professional/vocational decision-making and responsibility), i.e. it aims at professional/vocational capacity to act, for the purpose of active coping with professional/vocational situations, considering personal interests as opposed to those of ones social environment.
7. **ebAT** is targeted at two **levels of acts** likewise:
 - a) at the acts of the learner in an organised learning process and
 - b) at acts outside this process in their professional and private life.
8. **ebAT** is **holistic learning**, in the sense of a union of cognitive, affective/emotional-volitional and psychomotor learning processes. Individual and collective learning activities complement one another. Descriptive, regulative and normative matters of acquisition are offered in the diversity of their natural functions which activate as many senses as possible.
9. For the planning of the learning process, **ebAT** necessitates to consider the basic structure of human acts (complete act, compare p.38):
 - a) **Orientation** for the learning act to be performed – analysis of problems, defining of aims and goals, acquiring of information, planning of procedure, decision making
 - b) **Performing** of tasks
 - c) **Evaluation** of results/outcomes and reflections of approach.
10. **ebAT** follows the internal logic of learning (acts) in first place and the structures of the underlying discipline (subject) or the institutional determined subjects in second place.

11. **ebAT** replaces diversified, superficial learning with deepened dealing with **exemplary** fundamental **matters of acquisition**. The learners should be able to transfer thus acquired insights to comparable situations.
12. **ebAT** requires institutional and organisational conditions, which leave **scope** for the learners and facilitate **flexibility** in the modes of learning in class and in division into subjects.

4 Didactic principles in the process of vocational and further education

Seminar 2: Didactic principles

In the seminar we will discuss the importance of didactic principle for the planning, carrying out and evaluation of vocational education processes. Essential didactic principles will be characterised and the feasibility of putting them into practice will be discussed. The didactic principles of comprehensibility and of clearness will be focal point. We will work on some examples on didactic simplification (compare task 6).

Tasks

1. Explain the importance/relevance of didactic principles for pedagogic acts of the teacher.
2. What is the difference between a didactic rule and a didactic principle?
3. Give reasons for the statement: Comprehensibility is an attribute of subjective images.
4. Which options does the teacher have to visualise matters of acquisition in lessons?
5. With which didactic rules can the didactic principle of clearness put into practise?
6. Explain the possibilities of the didactic simplification of scientific statements according to HERING with the help of examples.
7. Explain the coherence of the didactic principle of activity and autonomy and the demand for instruction based on Act Theory (ebAT).

Didactic principles and didactic rules

Didactic principles

- Principles for lesson design, based on laws or coherences almost like laws or systematised experiences
- Presents/opens up space for thoughts and action for the teacher
- is valid for all forms/types of vocational lessons/learning/ instruction
- depicts coherence of arguments in the design of vocational lessons/learning/ instruction (descriptive function)
- have an effect on orientation, performing of tasks and evaluation of results/outcomes without determining them (regulative function)

Didactic rules

- special regulative indications, which go into detail on the implementation and correct application of the didactic principles
- refer to concrete situations

Selected Didactic Principles

- a) principle of educational effectiveness of teaching
- b) principle of the academic approach
- c) principle of methodology and systematology
- d) principle of activity and autonomy
- e) principle of illustration
- f) principle of comprehensibility

The didactic principle of comprehensibility

Teaching in a **COMPREHENSIBLE** way means that the terms/conditions of acquisition for the learner are designed in a way that he/she can acquire demanding matters of acquisition with reasonable effort.

Didactic rules for the easier application of the didactic principle of comprehensibility

Move from

KNOWEN	to	UNKNOWN
SIMPLE/BASIC	to	MORE COMPLICATED
NEAR	to	MORE REMOTE
EASY	to	MORE DIFFICULT

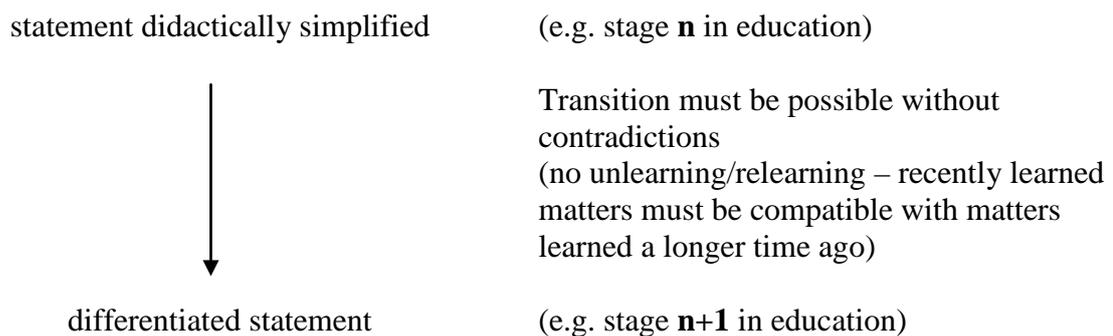
matters/contents

Didactical principle of didactic simplification according to HERING

Didactic simplification of a scientific statement is the transition of a *differentiated* term or statement (including special characteristics of the object) into a *universal* term or statement (including validity to the same extent about the same object seen from the same aspect)

(see HERING: Zur Fasslichkeit naturwissenschaftlicher und technischer Aussagen. 1959, S.92)

Criterion for the legitimacy of didactic simplification



Theoremes on the didactic simplification of scientific Statements according to HERING

Theoreme 1: Redemption (elimination) of secondary statements

This simplification can be achieved by transition from the statement expressing the differentiations of a subject matter, which presents in each aspect of the statement the general information, to a statement that contains this general information and encloses the differentiation of the subject matter.

Theoreme 2: Indicative redemption (elimination) of secondary aspects/partial statements

This simplification can be achieved by the transition of a statement expressing the differentiations of the subject matter where the different aspects do not contain corresponding (general) components or where these components are not used for the simplification, into a statement consisting of an aspect (partial statement) that is especially important for the reflection of a particular context providing the information that additional aspects exist.

Theoreme 3: Indicative Generalisation

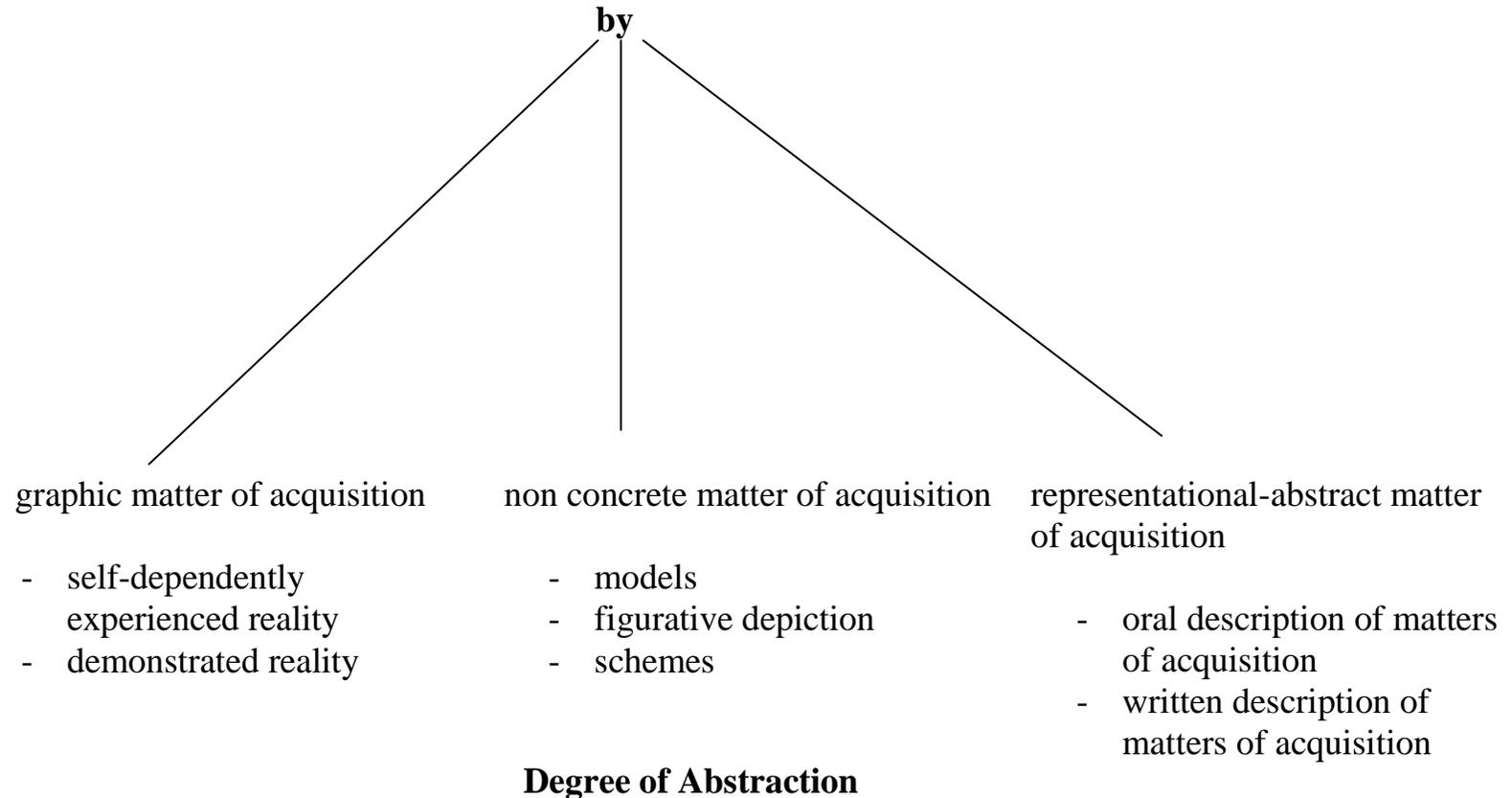
This simplification can be achieved by the transition of a statement expressing the differentiation of a subject matter where aspects may or may not provide corresponding (general) information on a general statement. This statement is narrowed by the information of the existence of particular restrictive characteristics on the extent of the original statement.

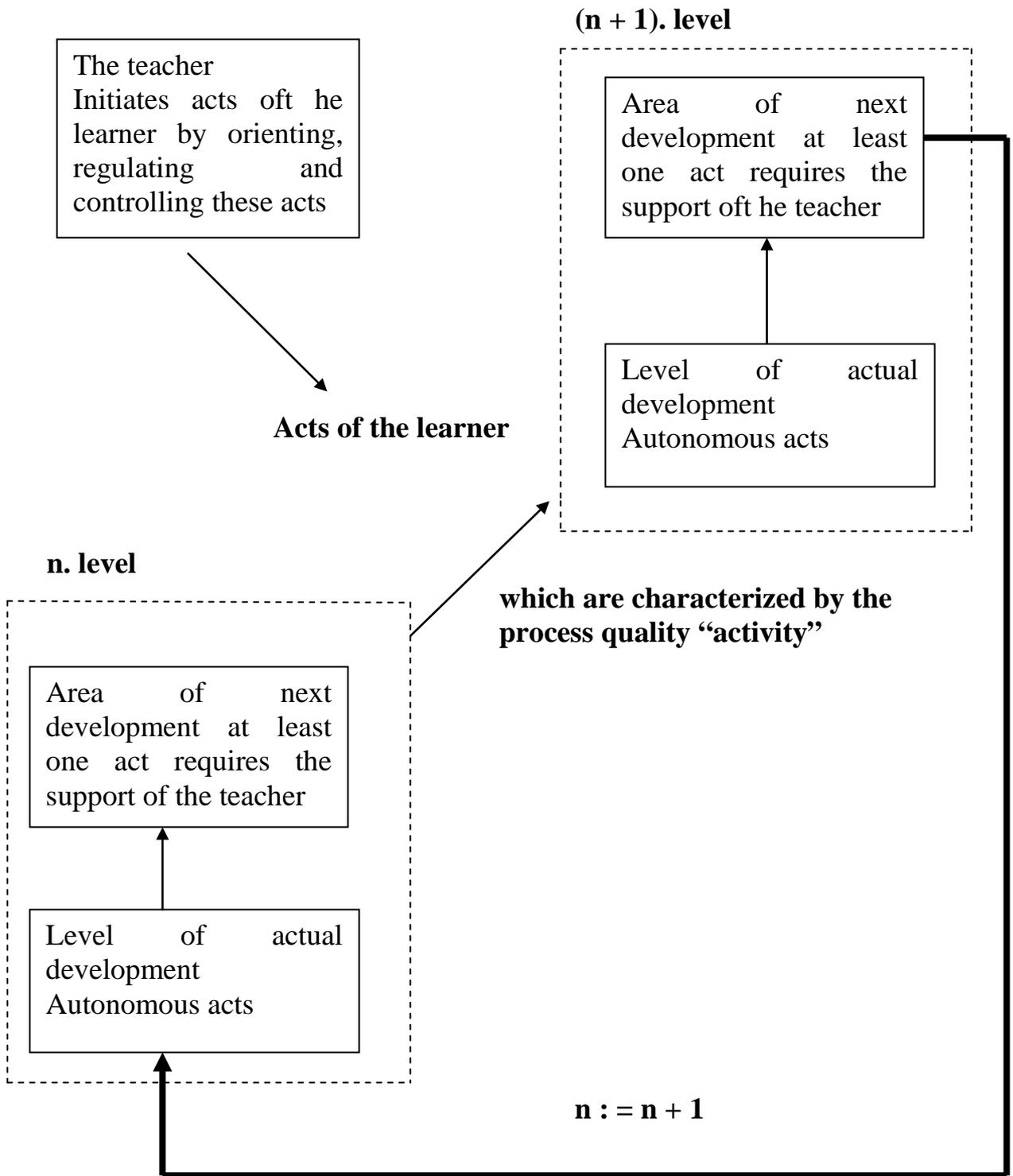
The didactic principle of clearness of mental images

Clearness of mental images is a characteristic trait of subjective images.

1. Matters of acquisition can be of
 - concrete,
 - non concrete or
 - conceptual abstract type.
2. A matter of acquisition leads to descriptive/demonstrative images if
 - a) the matter of acquisition has pictorial character.
 - b) the matter of acquisition allows connotations to matters already learned.
 - c) the spoken elements already known to the learner.
3. Clearness in this sense can be achieved if
 - a) the learner acts concretely with the matter of acquisition
 - b) the learner grasps matters of acquisition mentally by "observation".
 - c) the learner acts with the non concrete matters of acquisition (models, etc.).
 - d) the learner works with verbal (conceptual) matters of acquisition.
4. Clearness of mental images not simply achieved by the application of media in lessons that only trigger off perceptions and ideas/images/associations. The principle of clearness is only adequately taken into account if perceptions and images become starting point for thinking processes.

Demonstration/exemplification/illustration/visualisation in processes of acquisition





References on the formation of activity and autonomy

1. Activities for the learners, guidance by the teacher.
2. Organise learning in a way that will keep up or enhance the level of development of personality of the learners.
3. Plan learning activities **with the learners** and **for them**, not for yourself.
4. Activity and autonomy are formed mainly by activities of the learner. Let the learners therefore carry out the acts described in the learning objectives themselves. Demonstration is no surrogate for independent learning activity of the learners.
5. Construct tasks in a way that gives the learners the chance to learn independently and thus actively.

Didactic Principles – Summary

1. Didactic principles can be understood as a bill or a law to build up lessons and teaching arrangements in accordance to the learning abilities of the students, always depended on using perceptive preconditions too.
2. A principle is valid for all types and arrangements of learning and suitable for all target groups.
3. Must have a regulative function for the performance of teaching and learning.
4. Give influence to aim balance between learning needs and interests and the goal of learning and teaching at all.

Selected rules:

1. Principle of educational effectiveness of teaching: points out measuring learning
2. income and outcome value
3. Principle of academic approach: means to be up to date with scientific approaches of the learning matters. Have a look for new and modern needed knowledge.
4. Principle of methodology and systematology: everything we do, we always can find structure and we need instruments for thinking and decision making.
5. Principle of activity and autonomy: please note, all what you can do, your students are single individuals. They can take the opportunity to decide what they will do or not do.
6. Principle of illustration: use sensitive channels of income of perceptions in variety
7. Principle of comprehensibility: try to find a way of advertising demanded learning
8. matters of acquisition with reasonable and realizable efforts of teaching

Didactical Rules

All principle try to rule the teaching-learning-arrangements by the following way:

- (1) All activities of the teacher are primarily focused on an adequate to the learners perception (auditive, visual and physical).
- (2) The teacher has to have to give initiating moves to the learners to start a basic learning act through self activities of the learner.
- (3) By structuring the learning content and the matters of acquisition accompany the learners at anytime and give support step by step to a higher level of recognition about the real world.
- (4) Change from more instructing activities to more self oriented acts of the learners to solve problems.
- (5) The content of learning must be based on scientific knowledge, self reflection and recognition about that.
- (6) Organize learning loops to link current learning subjects to remoted knowledge and use the knowledge which the students have been learning actively.
- (7) Give support to find own strategies by the learners to get suitable knowledge about the matters of acquisition.

5 Didactic Elements of the Vocational and Further Education Process

5.1 Forms of Organization in the Vocational and Further Education Process

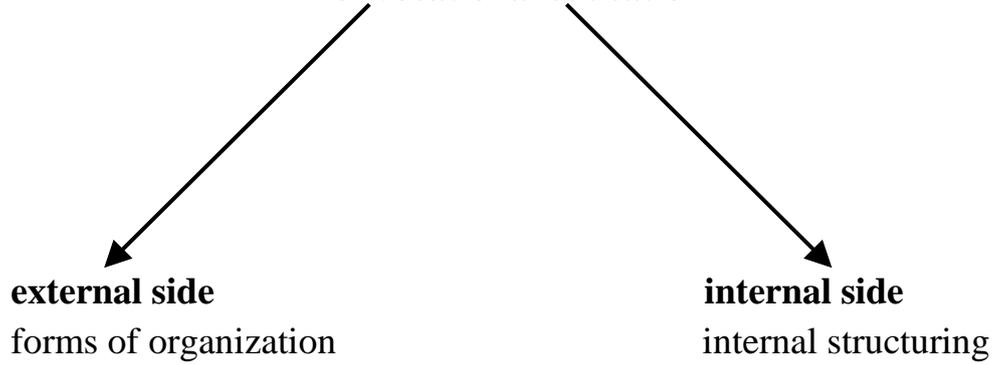
Seminar 3: Didactic-methodical Elements in the Design of Vocational Education - forms of organization -

Starting from reflections on the preparation of a lesson, elements of the design of vocational lessons will be classified and discussed. The main focus will be on forms of organisation of vocational learning and teaching. Classroom conversation and teacher talks will be discussed exemplarily for all forms of organisation of vocational teaching regarding their fields of application and criteria for design. The pros and cons of the different forms of organisation of vocational learning (teacher fronted lessons, group work, etc.) will be discussed

Tasks

1. Compile criteria for the design of teacher talks.
2. Prepare a teacher talk (10 minutes) on a topic related to your vocational subject. (obligatory as preparation for the next seminar)
3. Discuss the pros and cons of teacher fronted learning in vocational lessons/ lectures/ education.
4. Give reasons for the following thesis: Group work prepares the learners appropriately for job requirements in modern structures of production and services.

**Didactic-methodical design
of vocational education**



- (1) of vocational lessons/lectures
- (2) of vocational learning
- (3) of vocational teaching

- (1) didactic functions
- (2) methodical procedure

Seminar 4: Forms of Organization of vocational teaching

practising teacher talk

On the basis of criteria acquired in the seminar for the design of teacher talks, students will practise holding teacher talks they prepared, which will be analysed as regards its design.

Tasks:

1. Prepare a teacher talk (10 min) on a topic related to your vocational subject!
(Obligatory as preparation for this seminar)
2. Analyse the teacher talks according to the following aspects:
 - didactic intention
 - outline
 - internal structuring
 - clearness of mental images
 - linguistic presentation
 - body language

Training in independent training centers (interplant training facilities/institutes/institutions)

Developments in technology constantly bring about new requirements for future skilled workers, often multidisciplinary and beyond their job. Especially those demands that result from technological innovations which can not be met by smaller firms for the most diverse reasons. For learners in those firms this would possibly result in a training not so broad and based on best available technology. They would not have the same chances as compared to other skilled workers in their career.

Consequently it is necessary to complement industrial training education with training in training centers not run by the firms (überbetrieblich). Normally facilities/institutes/institutions used for 'überbetriebliche' goals of training are operated by Chambers of Trade and by guilds. There learners are educated in special fields of activity, that can not be realised in firms or would be very cost-intensive. The hairdresser's guild for example, often operate 'überbetriebliche' training centers where learners learn to work with modern techniques and technology that do not exist or are not applied in in all hairdresser's shops.

The in-firm training centers work with money from government aid.

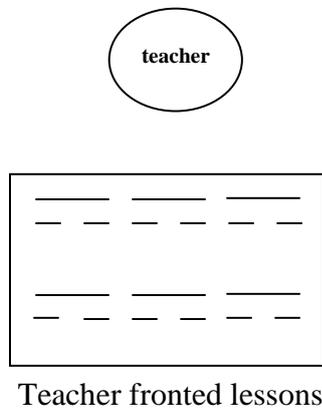
The training in these centers is carried out according to 'Ausbildungsordnungen' or framework plans for training.

'Ausserbetriebliches' training (external training)

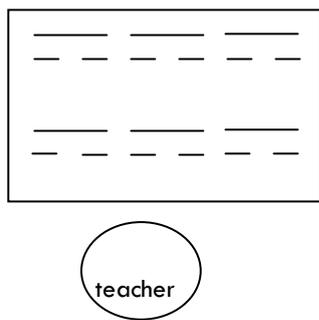
'Ausserbetriebliches' training (not in firms) is for adolescents who did not find an apprenticeship (in-firm/in-plant training). In this case the contractual partner is a public (state-owned) or nonprofit organisation instead of a firm. In this organisation's workshops the practical part of the apprenticeship is carried out. This type of apprenticeship is financed with money from public funds.

Forms of Organisation/Social Forms of Learning

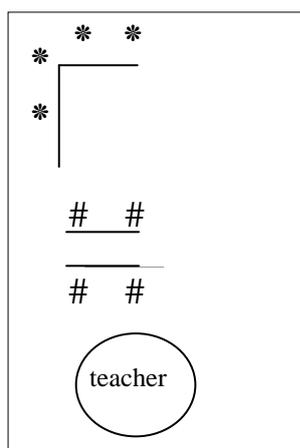
Form of organisation	Characteristics	Advantages	Disadvantages
----------------------	-----------------	------------	---------------



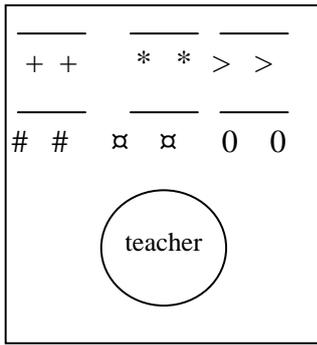
- teacher turns towards all learners
- collective procedure under guidance of teacher
- teacher amalgamates all interaction on him/herself



- guidance by teacher at beginning
- temporary retreat of teacher
- learners work alone
- evaluation under guidance of teacher

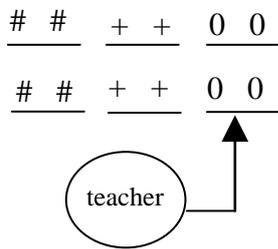


- learners divided into groups
- teacher initiates
- group is responsible for solving the given tasks



- two learners work together
- otherwise like groupwork

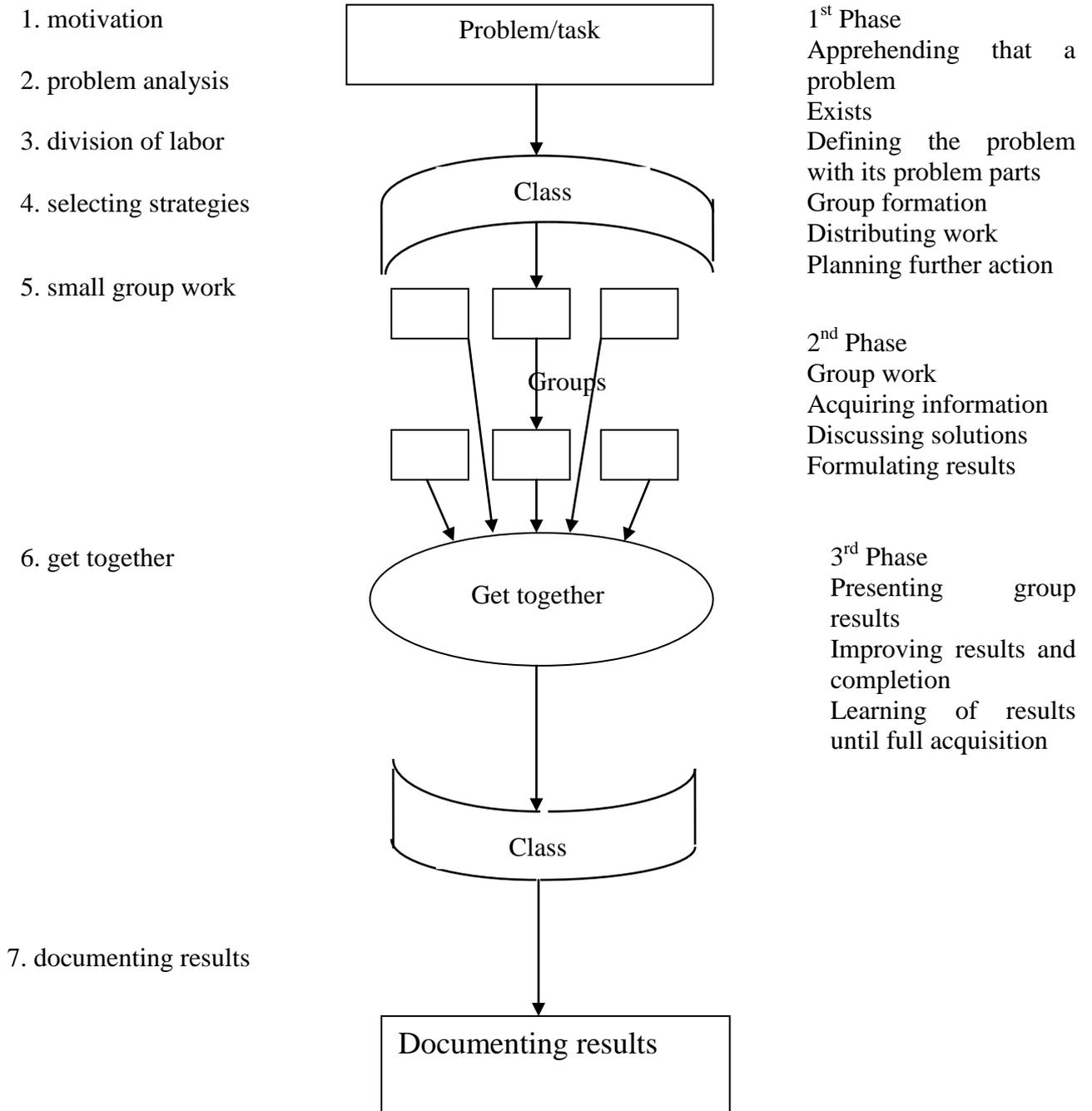
Partnerwork



- teacher arranges learners in learning points
- learners take turns at the different learning points

Learning at learning points

Procedure of Group Work



Vgl. Vogel, H.: Unterrichtsformen II
 Ravensburg 1975

Introductory remarks

1. We need to differentiate between project work and the project itself.
2. A project is a realisable plan, that has the function of a means of acquisition in the lesson/lecture.
3. Project work is a creative and thus a didactic and methodical problem, that learner and teachers have to solve together.

Characteristics of project work form a didactic point of view

1. A project is existent.
2. The work on the project requires structures of solving problems.
3. The problem allows at least two solutions.
4. Project work is oriented at the experiences and interests of the learners.
5. Project work is characterized by complete learning acts.
6. Project work is carried out in bigger or smaller groups and also alone.
7. Project work is multidisciplinary and beyond their job.
8. In project work different methods are applied.
9. Project work is coined largely by self-organisation and responsibility.
10. The non concrete project as an objective or subjective utility value.

(compare KATH, 1982, 1992)

5.2 Didactic Intentions and didactic function

The didactic intentions, the didactic goal

The didactic intention

is the aim, the intention , with which the teacher initiates learning acts

The goal, general

is a situation or state desirable in the future, which is planned in the present

The didactic goal

Is the planned change of a desirable situation or state of the learner as regards his/her development of personality with a learning act.

Possible functions of a goal:

1. orientation
2. incentive
3. evaluation

Didactic Functions

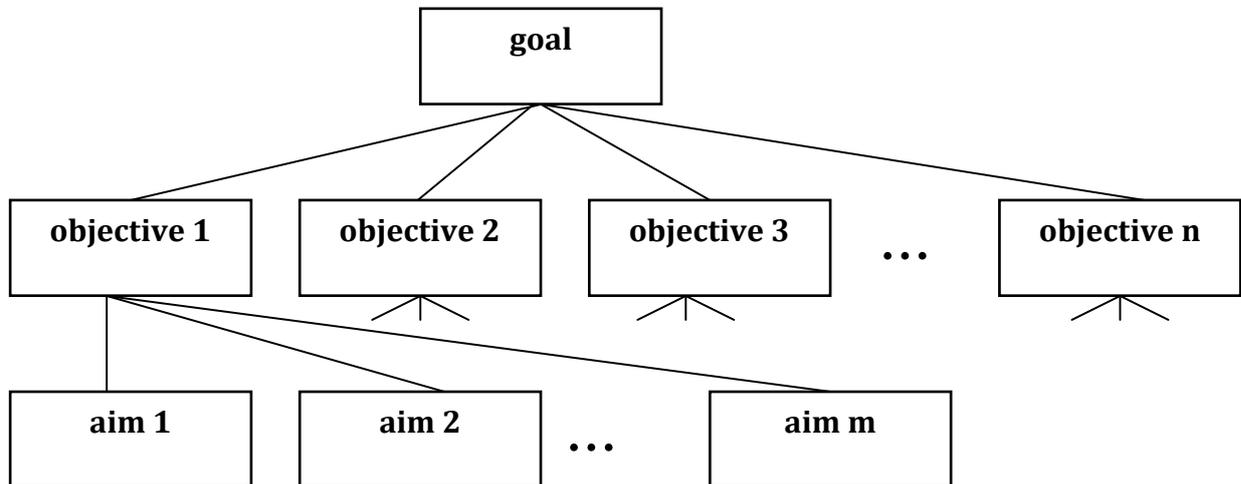
Group of Elements	Didactic Function	Didactic Intention	Stages of Learning Acts
1.	Starting with practical examples Getting in the mood of Motivation Orientation for action Preparation Decision for action	Getting the learners ready for the learning act	Orientation
2.	Working on new contents/learning acts	Opening up the contents for the learners	Performing of tasks
3.	Working on known contents/learning acts Consolidation of formerly acquired knowledge/skills	Improving the availability of learning results for the learners	Performing of tasks
4.	Evaluation of results/outcomes Assessment of learner performance	Feedback on the performance level for learners and teacher	Evaluation of results/outcomes

Structure of a Complete Act

- Orientation act: Orientation about the act that is to be carried out by:
- a) Presentation of a sample of the act and its aim
 - b) like a) and hints on carrying out the act
 - c) analysing problems and developing a structural image of the act that is to be performed
 - d) Reactivating knowledge, skill volitional disposition necessary for the act
 - e) decision for an act
- Actual act: Carrying out the act
- Evaluation Act Checking and evaluating the act and its outcomes

Types of Goals

Aspect: Extent of validity (according to MÖLLER; CH. 1973)



Example:

Goal: The apprentice should be able to think mercantile.

Objective: The apprentice should be know monetary transactions.

Aim: The apprentice should be able to ennumerate the constituents of bills of exchange by heart .

Taxonomy of educational goals

A taxonomy is a type of classification, that correspond with the aspects of a scientific discipline

→ here: educational goals (Learning Targets/Objectives)

According to BLOOM four guiding principles exist:

Differences in learner reactions should be reflected

The taxonomy should be logic

The taxonomy should coincide with psychic phenomena, it should only deal with such changes of behaviour that are indicated by education

The taxonomy should be a descriptive system.

Minimum behaviour/output aimed at requirements for the wording of objectives according to BLOOM:

- The behaviour/output aimed at must be described in a way that makes it observable.
- Conditions under which the behaviour/output is to be demonstrated is to be indicated.
- The scale of evaluation (.i.e. The quantity of the quality of the course of the learning act) is to be indicated.

Example: the apprentice should be able to touch type 300 words with 160 characters per minute with 5 character mistakes maximum on a mechanical typewriter in a copying test.

Behaviour/output aimed at: writing

Conditions:

- mechanical typewriter
- touch typing
- copying test
- 300 words
- 160 characters per minute

Scale of control: 5 character mistakes maximum

A **learning objective** can be denominated **operational** if, referred to lessons/lectures, **everybody** in **every situation** and at **any time** understands the wording of the learning objective **in the same way**.

Seminar 5: Control and evaluation/assessment of learning efficiency

The starting point of our considerations is the function of control and evaluation/assessment in vocational education/lessons. In reference to HECKHAUSEN the characteristic traits of situations for evaluation/assessment will be discussed. Differentiated frames of reference for the evaluation/assessment of learning efficiency will be discussed regarding their suitability for the realisation of pedagogic and social functions of control and evaluation/assessment. The final/concluding topic will be practical reflections on the preparation and carrying out of tests.

Tasks:

1. How do you apply performance evaluation/assessment in an educationally effective way?
2. Why is calculating a total/final grade by forming the arithmetic average from different grades very problematic?
3. List at least 5 reasons for the necessity of performance control and evaluation/assessment in vocational education!
4. Discuss the suitability of performance evaluation/assessment with grades from the point of view of the pedagogic functions of control and evaluation/assessment of learning efficiency!
5. Speak out on the difficulty of performance evaluation/assessment by marking in practice oriented/instruction based on act theory (ebAT).

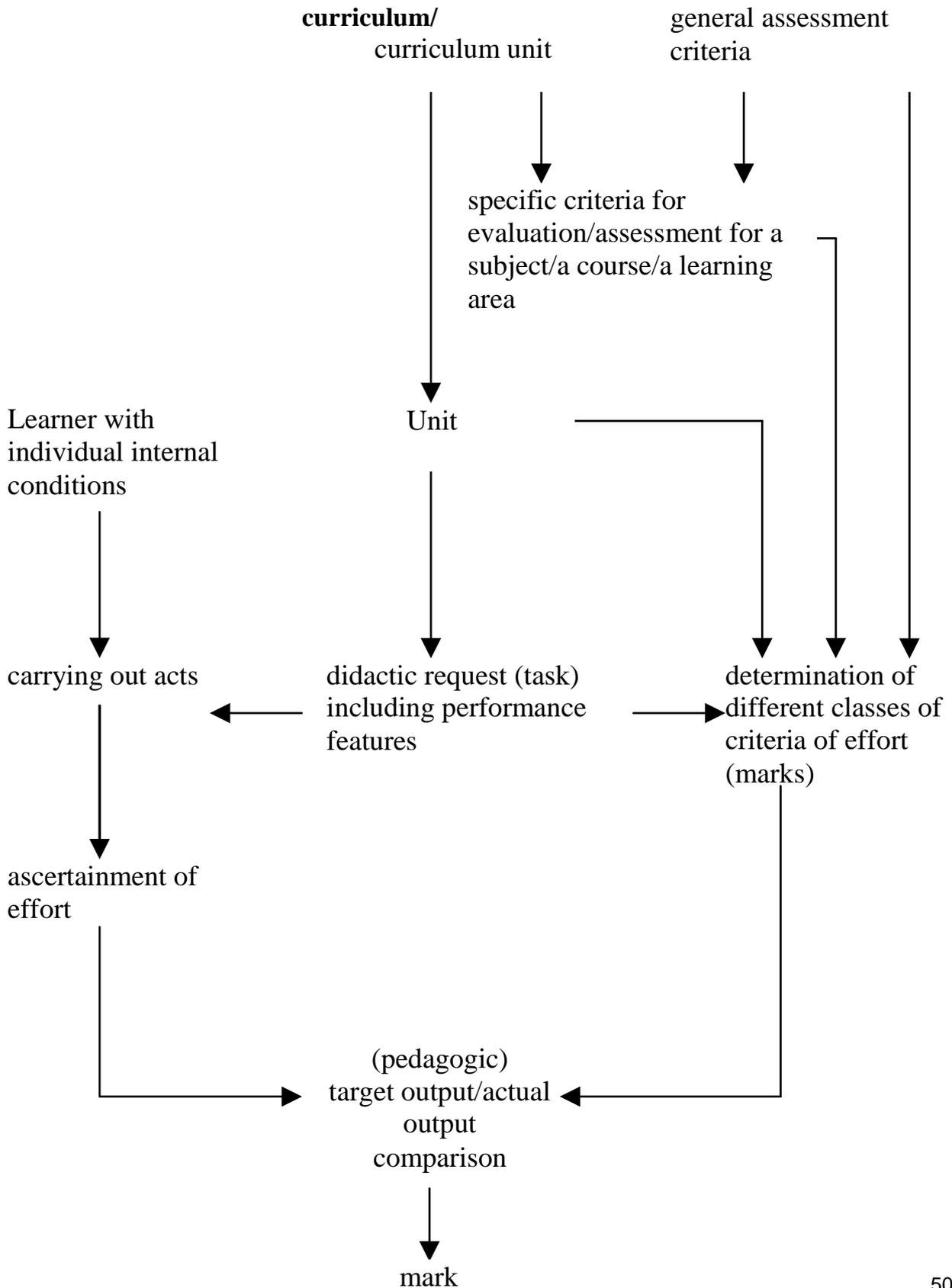
Characteristic traits of a situation for evaluation/assessment:

1. the task and thus the result of an act must be objectified
2. in relation to a scale of difficulty and “effort” respectively
3. feasibility of success or failure of an act
4. subjective binding “scales” for evaluation/assessment
5. dependence ('authorship') of the effort on acts

Evaluation/assessment in education/lessons comprises:

- the ascertainment of learning efficiency in consideration of their accomplishment
- the comparison of ascertained learning efficiency with a defined “scale”
- fixation of a judgement
- statement of the judgement

Evaluation Process



5.3 Teaching Methods

Seminar 6: Teaching methods according to Erkenntniswegstrukturen (structures of paths of cognition)

Starting from a discussion about the term teaching methods, we will compile teaching methods according to structures of paths of cognition on the basis of examples from vocational lessons/lectures. The main focus will be on inductive and deductive structures of paths of cognition as well as the progressive-reductive and the regressive-reductive structure of paths of cognition. The characteristics of the different structures of awareness lead to reflections on their suitability subject to the different conditions in vocational lessons/lectures.

Tasks:

1. Which parameters are to be considered when choosing methods for vocational lessons/lectures?
2. Explain the pros and cons of inductive structures of paths of cognition as opposed to deductive structures of paths of cognition! Under which preconditions would you decide for inductive structures of paths of cognition?
3. Design a lesson plan using a structure of paths of cognition! (Obligatory as preparation for the next seminar)

Teaching Methods in a Wider Sense

<i>Aspect</i>	<i>Term</i>	<i>Example</i>
Forms of organisation of teaching acts	Forms of organisation of teaching, teaching methods	Teacher talk, classroom conversation
Forms of organisation of learning acts	Forms of organisation of learning, social forms, forms of co-operation	Teacher fronted learning, group work
Concrete media used	Teaching aids teaching material, learning material	Working with a text book, conducting an experiment as demonstration
Structure of the lesson using subtasks	Didactic functions , phases of the lesson/lecture, formal steps	Preparation for working on new contents
Activation of learning acts	?	Explanatory-illustrative, problem oriented
Structure of the structure of awareness the learner is to follow	Teaching methods in a narrower sense	Deductive-inductive, analytic-synthetic
Structure of learning acts	Complex teaching methods	Project work (method)

By **teaching method** we describe a

system of action orientations by the teacher to initiate learning acts
with the aim of shaping personality traits,
which are aimed at achieving competence of action
(in a defined area of action)

Teaching methods according to structures of paths of cognition

Denotation of the structures of paths of cognition

analytic
synthetic
deductive 1
inductive
deductive 2

reductive

genetic
historic
?
?
?

Category pairs for identification

whole - part
part - whole
general - particular
particular - general
attaining true statements by truthful-logical conclusions
attaining true statements by non truthful-logical conclusions
imperfect - perfect
logical - historical
purpose - instrument
cause - impact
structure - function

Analytic procedure in lessons/lectures

Factual or mental dissecting of matters of acquisition in order to identify from a special aspect like essential constituents, characteristics, etc.

Hints on performance:

1. Introduce the matter as a whole.
2. Clarify the aspect of order (function, components, flow of energy or information, ...) that is to be applied.
3. Dissect the 'whole' matter according to the chosen aspect.
4. Emphasise the significance of the parts in the 'whole' matter and within the single object.
5. Differentiate between essential constituents or characteristics and those that are inessential for the intention.
6. Investigate the coherence of the essential constituents or characteristics.
7. Join the parts together to the 'whole'.
8. Make the gained insights about the 'whole' clear.

Inductive Teaching Method (particular – general)

Analysis of several facts which are supposed to have a common regularity



Emphasizing similar features in all facts.

Between the features of a fact are essential connections.



Formulating the realization, that in all examined facts each feature exists because of the other one.



Transferring this realization on all facts of the same type under the same conditions that is generalizing the relations between the features through induction.

Deductive Teaching Method (general – particular)

Problem or task description



Establishing general statements or rules of which at least one has to refer to the relevant fact



Step-by-step connection of the statements towards problem or task solution



Formulating the final concluding sentence, in comparison with the posed aim



If necessary, experimental corroboration of worked out finding

Rose, H.; Thomas, W.: Unterrichtsmethodik Elektrotechnik
Berlin 1986

The regressive- reductive method

Analysis of a given fact, which is in its appearance unknown to the learner or whose effect has to be traced back to a yet unknown cause.



Defining the goal of realization



Emphasizing such characteristics which are supposed to be of importance to the establishment of a realization



Assigning the fact to already known and explained appearances, causal relations, rules



Stating a thesis about the nature, cause, reason of the fact



Explaining the fact by means of the hypothesis

Progressive-reductive method

The starting conditions are:

A hypothesis about the nature, cause, reason of a fact



Analysis of the hypothesis



Drawing conclusions from the hypothesis, scrutinized, for example through experiment or observation in reality



In case there is a correspondence between conclusions and reality then the hypothesis can be considered as probably true, otherwise it is probably wrong

Rose, H.; Thomas, W.: Unterrichtsmethodik Elektrotechnik
Berlin 1986

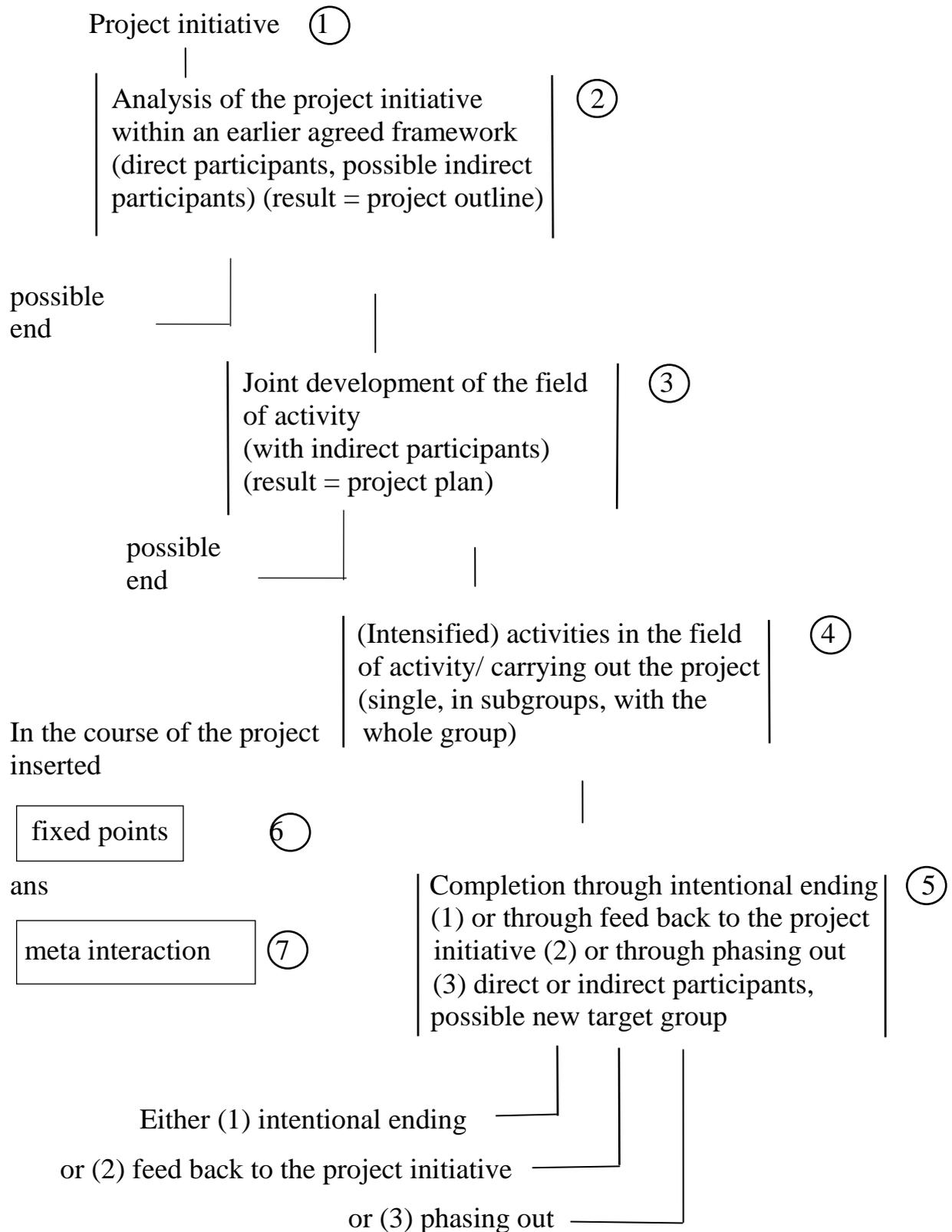
Seminar 7: Practising teaching methods

In this exercise we will discuss the drawn up lesson plans concerning their suitability. We will have to act on assumed preconditions.

Tasks:

1. Draw up a lesson plan using a path of cognition! (obligatory for this seminar)
Present your lesson plan!
2. Evaluate the suitability of the presented lesson plans taking the assumed preconditions into consideration!

Basic Pattern of the Project Method



Criteria for the Analysis of the Project Initiative

- interests of the learners
- educational value of the project
- feasibility of the project
- utility value of the project

The Project Outline

Contains information on

- the time limit
- the product
- the different fields of work (roughly)

The Project Plan

- list of activities
- distribution of activities among groups and individuals
- development of a time schedule for each activity
- qualification objectives (knowledge, skills)

important: the higher aim is not the product but the qualification of the learners

The End of the Project

- the intentional end
 - the project work ends with the completion of the product
- feed back to the project initiative
 - participants compare final result and starting point of the project
- phasing out
 - the strived for qualifications have been achieved through project work (certain skills, knowledge)

vgl. FREY, Karl: Die Projektmethode
Weinheim, Basel 1991

Problems of achievement assessment with the work in and with projects

- The contradiction between self-organization and self-responsibility of learners and the requirements for an individual achievement assessment
- The contradiction between cooperative learning organization and securing of individual authorship of achievement
- The contradiction between the pedagogical aim connected with the work in and with projects and control and assessment of the project product

The concluding points about the problem of achievement assessment with the work in and with projects are:

- 1) An exclusive external control and assessment of learning achievement by the teacher is not possible.
- 2) Control and assessment of learning achievement has to be carried out in cooperation between learner and teacher. Starting point for this is that the learner keeps a check on himself and the self-assessment by the learner, followed by reciprocal assessment of produced achievement by the learners. On this basis, the teacher is able to expound his assessment well-founded.
- 3) Although project work is characterized by product orientation the focus of control and assessment should not be on quality features of the product but on the process of problem solving.

Minimum Requirements for Project Work

teacher	learner
- knowledge about the vocational area of the learner	- master certain work techniques like, for example, communicating, co-operating in groups
- readiness for and curiosity about the learning processes that have their origin in the learner	- abilities like, for example, getting the gist of texts
- interest in solving problems together	- mastering basic communicative skills like, for example, oral reproduction of facts/issues and giving reasons
- interest in multidisciplinary problems	

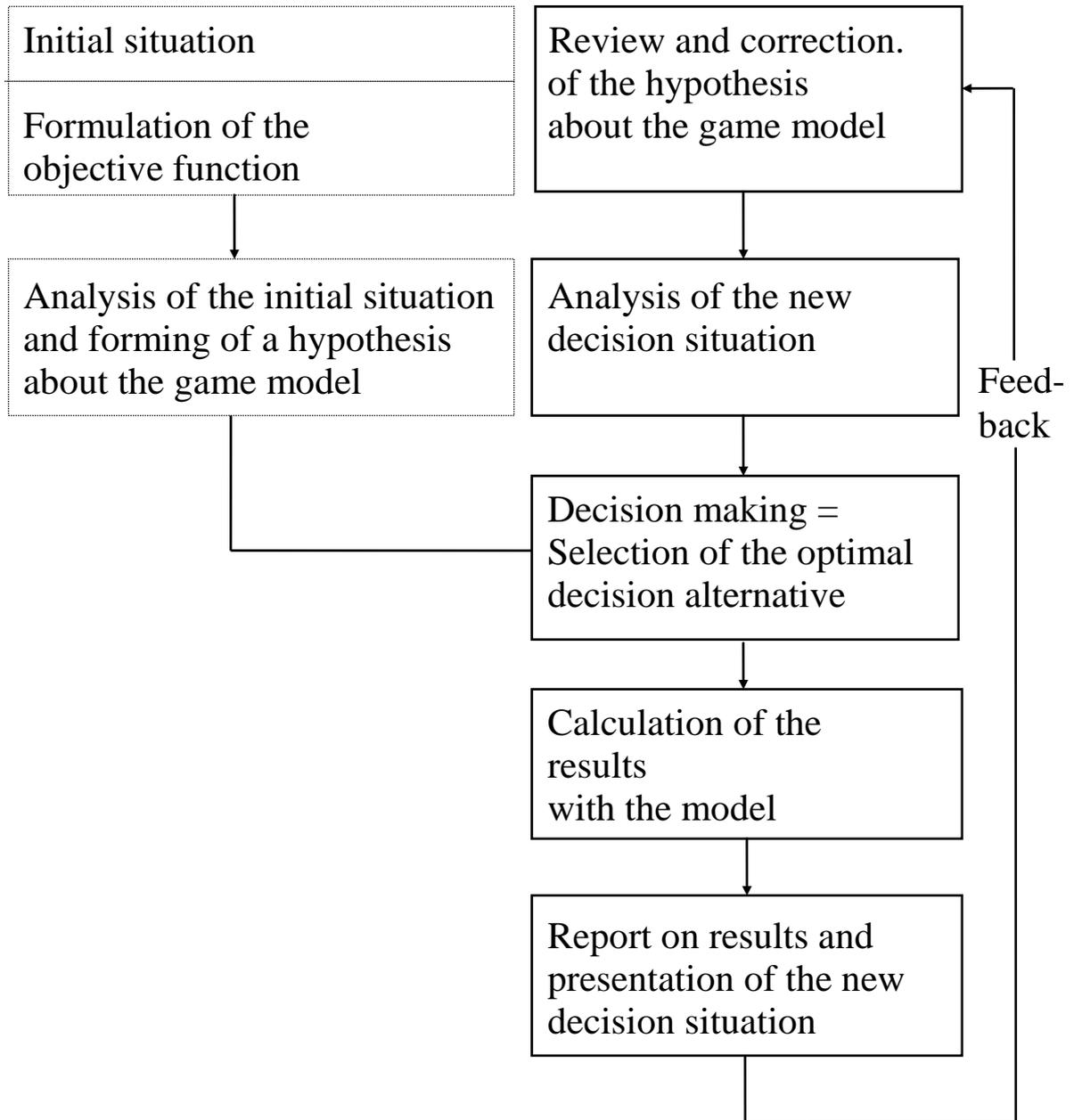
Tasks

1. How do you apply performance evaluation/assessment in an educationally effective way?
2. Why is calculating a total/final grade by forming the arithmetic average from different grades very problematic?
3. List at least 5 reasons for the necessity of performance control and evaluation/assessment in vocational education!
4. Speak out on the difficulty of performance evaluation/assessment by marking in practice oriented/'hands-on' learning!
5. Demonstrate the application of a teaching method in your lesson/lecture.
6. Explain methodical procedure of the teacher according to structures of paths of cognition with the help of an example.
7. Which intensions for the learner can be realised in 'Project Work'?

Variants of the work with case studies (comp. Kaiser 1976, S. 55)

Method	Problem recognition	Acquisition of information	Problem solving	Criticism of solution
Case-Study-Method	Focal point: hidden problems need to be analyzed	Information is given	Possible solutions to the problem are to identify and decisions to made	Comparison of the solution with the decision in the real world
Case-Problem-Method	problems are clearly stated	Information is given	Focal point: Possible solutions to the problem are to identify and decisions to made	Comparison of the solution with the decision in the real world
Case-Incident-Method	the case is incomplete represented	Focal point: Information is to acquire independently	Possible solutions are to identify. The case is solved.	
Stated-Problem-Method	problems are given	Information is given	The final solutions are given. It will look for alternative solutions.	Focal point: Critique of the given solutions

Process of business game



(comp. Kaiser 1976, S. 109)

Overview of the didactic Elements from the Aspect of didactic-methodical design the educational process

External Structure			Internal Structure												
Forms of organisation			Didactic intentions	Didactic functions	Elements of methodical procedure										
					Teaching methods		Elements with mediator function		Re-quests	Content, topic					
of vocational lessons	of learning	of teaching	getting the learner ready for the learning act	Motivation Orientation Preparation	Simple structures of paths of cognition	Complex structures of paths of cognition	Media				direct indirect	Aspects of structure: <ul style="list-style-type: none"> • Content linking • Energy linking • Informational linking • Vocational fields • Occupational activity • Systematics of sciences • ... 			
							Opening up the contents for the learners	Working on new contents/learning acts					Technical components	Information components	
Excursion Lesson Project week Practical course/ training Self-study (Homework)	Teacher fronted lessons Individualised instruction Group work Partner work Learning at learning points	Teacher talk Conversation/ discussion Demonstration	Improving the availability of learning results for the learners	Working on known contents/ learning acts Consolidation of formerly acquired knowledge/skills	deductive ₁ inductive reductive deductive ₂ analytic synthetic genetic historic ...	Working with and on projects Case study Role-playing Business game/ map exercise Brainstorming Brainwriting Methods for structuring solutions of problems Methods for decision making when problem solving Adapted research methods ...	Work sheet Textbook Instructions for work Software Documentation of experiments ...	Videos Documentation of construction Instruction sheets Operating instructions ...							
Learning in the working process Practice Instruction			Feedback on the performance level for learners and teacher	Evaluation of results/outcomes Assessment of learner performance											

Problem-oriented Learning

Problem oriented learning refers to learning that depends on structures for identifying and solving problems. Applied to lessons/lectures, this means that for the learner a problem is at hand when he/she is confronted with a novel, not straightforward situation and the ways and means for the mastery/control of this situation or is not able to transfer them to the situation.

A problem in problem-oriented learning has two functions. On the one hand it is matter of acquisition and on the other hand it is trigger for productive thinking processes that generate abilities for solving problems. Thus problem-oriented learning aims mainly at the forming of the methodic component of vocational 'Handlungskompetenz'.

Problem-oriented learning in lessons/lectures usually proceeds in the following steps:

1. confrontation with a difficulty
2. limitation and containment of the difficulty
3. wording of the problem
4. compiling assumed solutions
5. verbalising or visualising of the deficit with the solution of the problem
6. developing the solution
7. verifying the solution

Frequently not all steps can be carried out in lessons/lectures because problem-oriented learning needs time and as few restrictions and as little pressure of time and pressure to perform (marks!) as possible. The teacher has to make clear to the learners which steps were not carried out/performed.

The teacher has the function of initiator in problem-oriented learning. He/she presents no solutions, not even the way to the solution. He initiates thinking processes, then stands back and leaves the learners find out themselves. The teacher allows meanders of the learner during the process of solving the problem depending on the degree of motivation.

KNOWLEDGE

The **term knowledge** identifies the contents of the memory of an individual. Knowledge develops as a result from processes of becoming aware that are manifest in acts (both mental and practical) and that are precondition for those forms of human acts.

The build-up of knowledge takes place in an individual **construction** process.

This process can be described as a constant linkage of new and of already existing elements by relations. The results of this linkage are constituted as elements of higher order, that can once again be linked-up. Construction processes are open at the top and at the bottom, but always tie in with the already existing cognitive repertoire.

The result is a structure of knowledge unique with each individual.

The knowledge stored in the human mind is structured.

Structure:

- structure of partitions (elements) based on each other in a connection stabilising the system

Structure of Knowledge:

- the structure of information stored in the human mind and their connections among each other

- constitutes itself from the quantity of its elements and the entirety of relations that connect these in manifold ways

- consists of

- Schematic (partial) structures, in which terms, operations and acts are depicted and
- Systematic structures (“general knowledge”).

- are generated by construction processes of the individual. All acts of the individual activate connections between elements that were formerly unconnected elements, i.e., every act causes structures of knowledge.

APPROACHES OF ENGINEERING PEDAGOGY TO IMPROVE THE QUALITY OF TEACHING IN ENGINEERING EDUCATION

Steffen Kersten

Technische Universität Dresden, Institut für Berufspädagogik
01062 Dresden, Steffen.Kersten@tu-dresden.de

This article outlines approaches of further education in the field of engineering pedagogy / engineering didactics for the development of qualifications for the design of teaching and learning processes in engineering education. The quality of academic teaching is decisively determined by the qualifications and competencies of the teaching staff, which also include university pedagogical capabilities. However, the usual educational biographies of university teachers in the engineering sciences do not include educational or didactic studies. Quality management systems at German universities have therefore increasingly focussed their attention on pedagogical further training programmes for this target group over the past 10 years. Often, these further training offers overlook the fact that general didactic approaches do not correspond to the needs of academic teaching in the specific sciences. The article therefore deals with approaches to the engineering pedagogy qualification of teaching staff in engineering education.

Keywords: *Engineering Didactics, Higher Education, Engineering Education*

Understanding of "Engineering Pedagogy"

Engineering pedagogy has a very long tradition at Technische Universität Dresden. The discussion on technical education and technical teacher training at TU Dresden (at that time Royal Technical Educational Establishment in Dresden) can be retraced to 1851. With the establishment of the Institute for Engineering Pedagogy by HANS LOHMANN in November 1951, teaching and research in the field of engineering pedagogy was finally institutionalized. LOHMANN focussed his research on the relationship of technology and technical teaching. Therewith he laid the foundations for an understanding of engineering pedagogy, the purpose of which is the targeted design of technical and technologically specific teaching and learning.

A central role in LOHMANN's approach of engineering didactics was played by the concept of technology. He defined technology by its function "to transform the natural world" (cp. Lohmann 1953/54, p. 619). The task of an engineer is to develop this technology. Engineers are therefore to become qualified in such a manner that they are able to solve technical design problems. In contrast to this, the activity of natural scientists is focussed on the discovery of relationships in the world and, thus, solving scientific knowledge problems. Invention and discovery require different ways of thinking and, thus, different methods of academic training.

Another concept of engineering pedagogy which was developed in the 90s needs to be distinguished, though not necessarily separated, from the latter understanding. For students in engineering science courses, a future engineer's ability to accomplish social communicative processes in modern structures of production and service has become a focal point of engineering pedagogical considerations.

In Greek language, the etymological meaning of the term "pedagogy" includes the word "agein", which translates to the English word "lead", in addition to the word "pais" (boy). Thus, the focus of this view of engineering pedagogy is the development of teaching concepts for the preparation of future engineers for their leadership roles in changing structures of production and service. The following article is aimed primarily at an understanding of engineering pedagogy in the context of pedagogy of university engineering education.

Concept of a demand-oriented "Engineering Pedagogy"

An object-related reasoning concerning designing of learning and teaching processes in academic engineering education illustrates the scientific character of related questions. Verifiable pedagogical and/or psychological qualifications are legally fixed requirements for a teaching career at all levels and in all types of schools of general and vocational education. In contrast, in the sector of higher education it is assumed that lecturers have teaching abilities due to their high academic qualifications.

Evaluation results regarding the teaching quality in higher education significantly show this assumption to be only partially correct (cp. Krempkow, R.; König, K.; Ellwardt, L., 2006). A major reason for this is the complexity of the influence factors and relationships concerning the design of a demand-oriented education in engineering sciences. In this context, the term "design" includes planning, implementation, and evaluation of teaching and learning in engineering education.

The requirement to gear engineering education to the demands of the economy, which is determined by the specifics of the engineering labour, is meant when speaking about demand-oriented and employment-based engineering education, respectively.

Requirements are understood as necessary personal dispositions for successfully managing the profession-specific work activities. They are thus determined by the prevailing structures of production and service. The change from TAYLORistic production structures to structures of lean production in the past 40 years has considerably changed the engineering activities, and with them the requirements on engineers. A reference in this context is a study by FRIELING (cp. Frieling 1993), who investigated these changes in the German automotive industry in the 90s in detail, and who characterised the new production structures as follows:

- Process-chain-oriented company organisation instead of functional hierarchies
- Customer-orientation instead of product-orientation
- Responsibility for the project/venture and budget instead of hierarchically structured task management
- Working in teams or groups instead of working alone
- Complete operations instead of individual/single acts
- Self-regulation instead of standardised input/guidelines
- Involvement instead of heteronomy
- Continuous improvement instead of hope for innovation.

(cp. Frieling 1993, p.32)

Modern engineering education has to consider these developments in its curricula and training methods.

Influence factors of engineering education

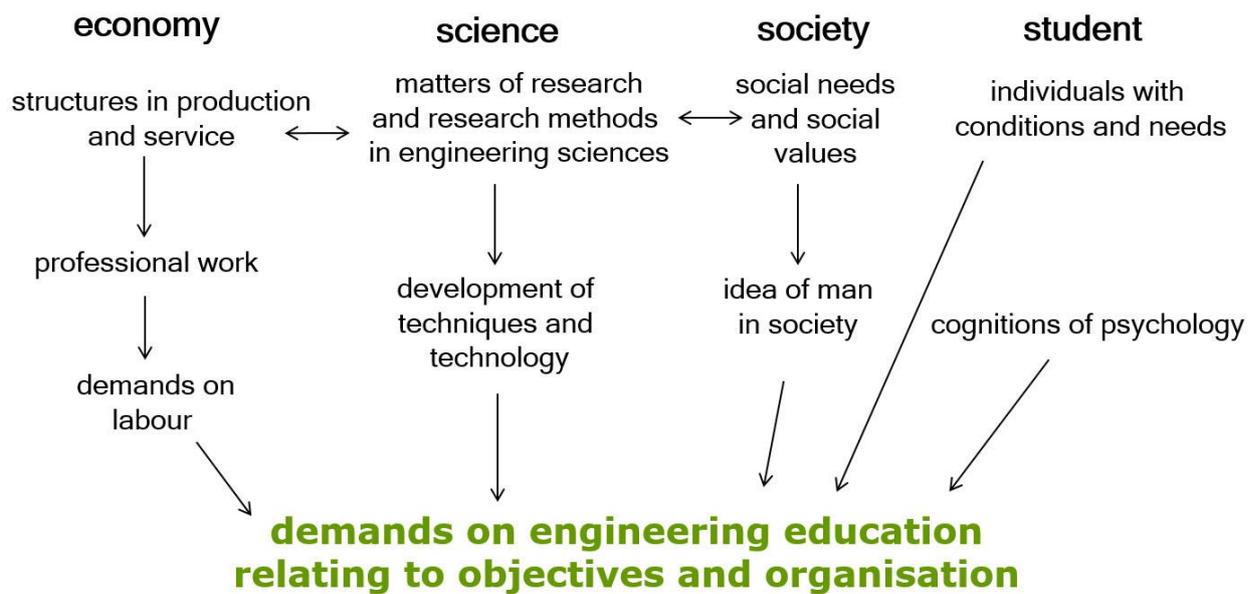


Figure 1: Factors influencing on demand-oriented design of engineering education (Kersten 2011; p.3)

In addition to these dynamic requirements, a variety of stable long-term requirements related to the personality dispositions of engineers result from typical engineering activities. An example is the typical way engineers think/reason. For instance, in the analysis or the design of technical systems, the thinking in the categories of “part – whole” in the relationship between structure and function plays a vital role. The calculation of technical systems by deductive structures of thinking is based on trusted statements or laws. However, in technologically diagnostic processes, progressive-reductive patterns of thought in cause-effect relationships play an essential role. Such considerations lead to scientifically-based decisions for teaching methods in engineering education in order to support the development of such structures of thinking.

A second major factor influencing the training of engineers is the field of engineering sciences itself. A scientific discipline is defined by its particular matters and methods of research. Regarding the matters of engineering sciences, the terms technique and technology play a key role. Technique and technology contain processes of change (form and structure), transport, and storage of material, energy, and information (cp. Wolffgramm 1994). The views on what technique is and which function it has in relation to nature and society is also subject to changes. A change of the matter of a scientific discipline has an impact on teaching in this discipline. The systems of statements in engineering sciences (descriptive matters), the systems of typical action rules for engineering activities (regulatory matters), and the systems of typical standards for engineering activities (normative matters) are different from those 60 years ago. Without adaption, LOHMANN’s approach to teaching technology is likely to fall short of meeting the requirements of modern engineering education. However, it can be considered a suitable starting point for the development of modern concepts of engineering education.

Closely related to the term "technology" is the society as a factor influencing engineering education. Technique not only arises from the application of natural laws and theories in engineering sciences, but is also part of the technical possibilities and the socially desirable aims (cp. Heidegger/Rauner 1989, p. 20). In this respect, the development of technique and technology

is also driven by social needs. In addition, a society also has an idealised image of its members. Maturity, ability to democracy, the willingness to active shaping are just a few personality traits that are included in this ideal. From this follows also the educational mission of our universities.

The fourth important factor influencing engineering education is the low rate of success students have at German universities, which is often explained by deteriorating levels of education in preceding educational institutions and the resultant lack of ability to study. I do not agree with such a general statement. But even if this thesis were true, it is economically not justifiable to let half of all young people who are interested in engineering fail in their educational intentions.

So why not use concepts of engineering education which consider these changes in the anthropogenic conditions of the students and which are based on the latest findings of educational and developmental psychology in the design of teaching and learning in higher education? Perhaps the obstacle is the inadequate funding of universities and the resulting poor student-teacher ratio, but certainly also the largely inadequate insight of the teaching staff at universities in these complex relationships of engineering pedagogy.

Curricular Approaches of Engineering Pedagogy

Qualified engineering activities are the foundation of any long-term economic development. Therefore, the prime task of universities is to provide academically trained professionals for the economy. The economic development of the world, with its associated increase of more qualified activities in manufacturing, services, and research, increasingly require well-trained engineers that meet the requirements of the economy and society. To this end, the discussion about curricular approaches of engineering pedagogy will contribute by improving the quality of academic engineering education.

The discussion of qualification concepts for teachers in engineering education is not new. Founded in 1951, the Institute for Engineering Education was primarily responsible for the qualification of teachers for the GDR's engineering education. In connection with the 3rd Higher Education Reform of the GDR, university pedagogical qualifications became a compulsory prerequisite for a teacher's license at universities (Law Gazette of the GDR II 1968, no. 127, p.1004f). In the following years, the East German universities developed appropriate training concepts in order to comply with this law. This historical aspect of German university pedagogy has, in my opinion, not been exhaustively scientifically investigated.

With the founding of the International Society for Engineering Pedagogy (IGIP) in 1972, a first European body was created to coordinate the discussion about appropriate engineering pedagogical qualifications. ADOLF MELEZINEK has very great merits in this respect. The decades-long international exchange on questions of engineering pedagogy led to a curriculum on the basis of which 35 accredited training centres are now offering further education for an "International Engineering Educator (IGIP)." The modular-structured curriculum addresses a very broad target group (engineering students, university lecturers, vocational school teachers), which, however, does not take into account the features of specific professional fields. Nevertheless, a standard has been developed with these curriculum, which forms the basis for many national approaches. Currently, various universities from all continents of the world are working to provide special modules for this curriculum for an online study.

	Module Description	CPs at least*
	Totally	20
	Core Modules	7
MC1	Engineering Education in Theory	2
MC2	Engineering Education in Practice	3
MC3	Laboratory Didactics	2
	Theory Modules	5
MT4	Psychology	2
MT5	Sociology	1
MT6	Engineering Ethics	1
MT7	Intercultural Competence	1
	Practice Modules	5
MP4	Presentation and Communication Skills	2
MP5	Scientific Writing	1
MP6	Working with Projects	1
MP7	ICT in Engineering Education	1
	Elective Modules (1 CP per subject)	3
ECP8	Evaluation of Student Performance	1
ECP9	Quality Management	1
ECP10	Portfolio Assessment	1
ECP11	Creative Thinking	1
ECP12	Coaching and Mentoring in Education	1
ECP13	Collaborative Work	1
ECP15	Teaching Subject in English (CLIL)	1
ECP16	Info Literacy	1

IGIP Prototype Curriculum (Berlin, 12 March 2013)

* One credit point (CP) corresponds to 25 to 30 hours of work.

Figure 2: IGIP-Curriculum Engineering Pedagogy
(<http://www.igip.org/igip/ing-paed-igip>)

One of the accredited training centres for "International Engineering Educator (IGIP)" study courses is the TU Dresden Institute of Vocational Education. Financed by the European Social Fund, we had the opportunity to develop and test a needs-oriented continuing education course for academic teachers in the field of engineering science between 2010 and 2012. We are currently continuing this work in cooperation with Chilean universities. On the basis of empirical data collection at the University of Applied Sciences Zittau/Görlitz and the Universidad Autónoma de Chile, the following needs in the field of engineering didactics were identified:

1. "Theoretical and practical knowledge about the didactics for the teaching and learning process in engineering";
 2. "Evaluation and assessment of the students' learning achievements";
 3. "Knowledge about how to design effective measurements of the learning accomplishments";
 4. "Didactics principles for the teaching and learning processes in engineering";
 5. "Knowledge of special forms for teaching at the university level";
 6. "Organisation of teaching and learning processes for the scientific formation of engineers";
 7. "Use of didactic resources and of information and communication technologies (ICTs);
 8. "Knowledge about the procedures for the recollection and measurement of the learning achievements";
 9. "Analysis about the concrete activity of engineering and the knowledge coming from the engineering sciences";
 10. "Knowledge about the scope of action of didactic resources";
 11. "Structuring of teaching and learning processes for the scientific formation of engineers";
 12. "Knowledge about the design of didactic resources for the teaching and learning process";
 13. "Knowledge and ability for the preparation, execution and feedback of the teaching process";
 14. "The fundamentals to determine the technical subject matters within the field of engineering"
- (Kersten, Simmert, Gormaz 2015, p.6)

These empirical investigations formed the basis for the development of a curriculum for an advanced training course in the field of engineering pedagogy, which has been evaluated as a success several times at German, Chinese, and Chilean Universities in recent years.

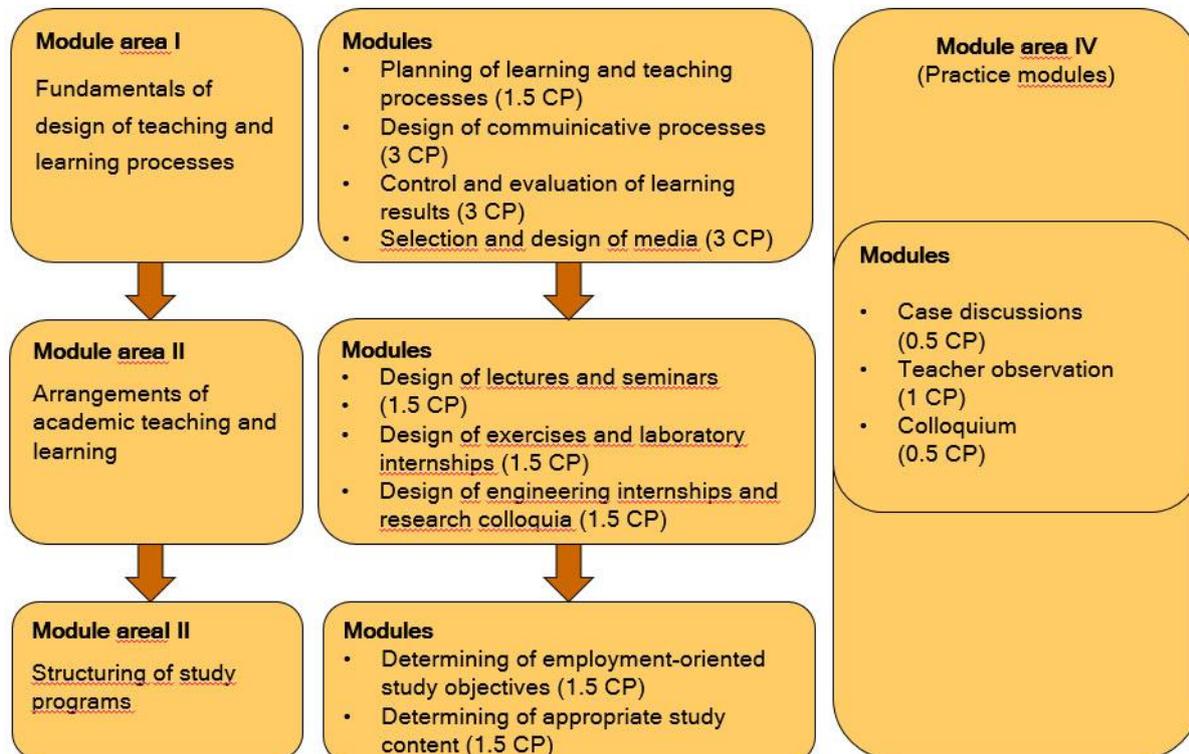


Figure 3: Developed Curricular Structure for the University Didactical Qualification of Teaching Staff in Engineering Sciences
(Köhler, Umlauf, Kersten, Simmert 2013, p.19)

The different modules are systematically based on each other. All modules are aimed at the development of scientifically-based, application-oriented action rules for the planning, execution, and analysis of academic teaching and learning in engineering sciences.

The didactic concept of the training programme provides teaching-learning arrangements in coordinated phases of classroom study, self-directed learning, as well as individual coaching.

In particular, the phases of self-directed learning and individual coaching are supported by internet-based learning scenarios. The selection of the e-learning tools is determined exclusively by their didactic purpose and functions.

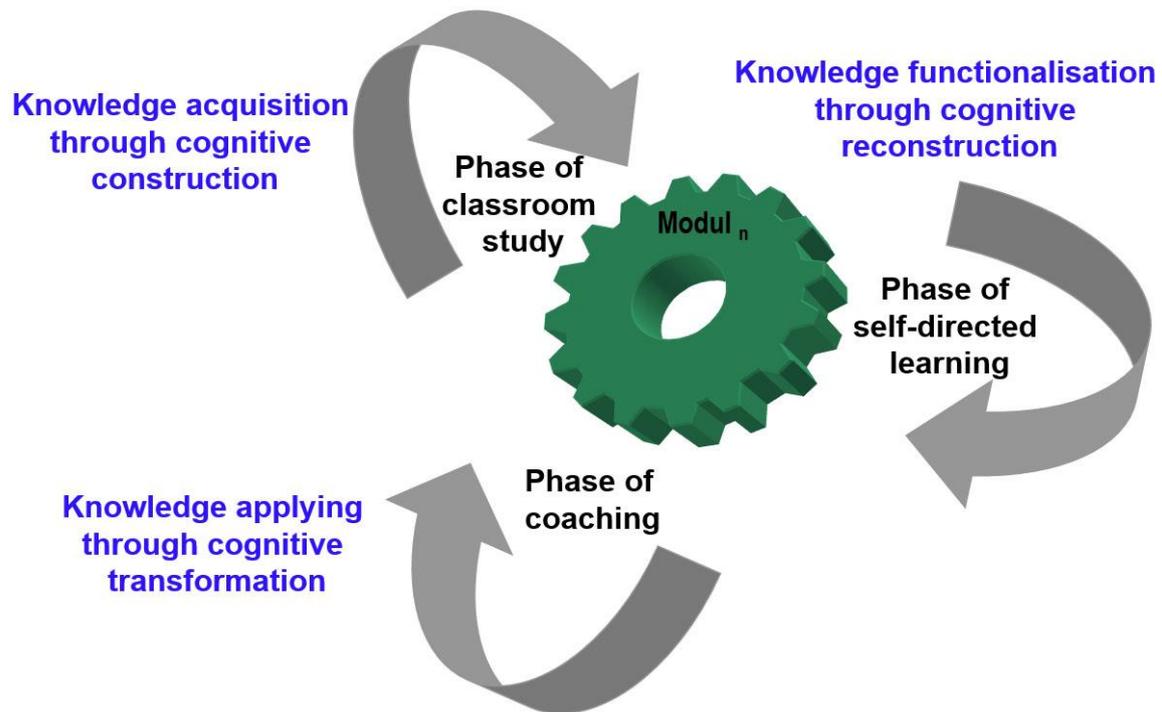


Figure 4: Structure of a Learning and Teaching Arrangement (Hortsch, Jentzsch, Borchardt 2003, p.65)

All modules are represented in a contemporary learning content management system. These are arranged similar to the course structure and include the multimedia-based learning materials. This includes the learning content, exercises of varying difficulties, examples of teaching and learning scenarios, and tests. In addition, extensive tools for communication between learners and experts are available: chat, forum, wiki, email, podcasts, and blogs. The participant can store their files in a private folder and document their progress in a portfolio. In addition to designed and managed online courses with extensive features, it is also possible to form individual online learning and working groups. The managing of the course content, the access control, and the communication can be done by the teaching staff or by skilled management personnel. For mobile learning, a special mobile version is made available.

The demand-oriented advanced training is accredited both by the International Society for Engineering Education (IGIP) and by the Scientific Society for Engineering Education (IPW). The detailed module manual can be read in KÖHLER, UMLAUFT, KERSTEN, SIMMERT 2013.

The focus of the current discussion on the pedagogical further training of academic teachers of engineering sciences is a curriculum approach of the Scientific Society of Engineering Education (IPW). Under the leadership of GUDRUN KAMMASCH, an international work group of specialists from different scientific disciplines has designed an engineering pedagogy curriculum and presented it in Eindhoven at the annual conference of the society 2015.

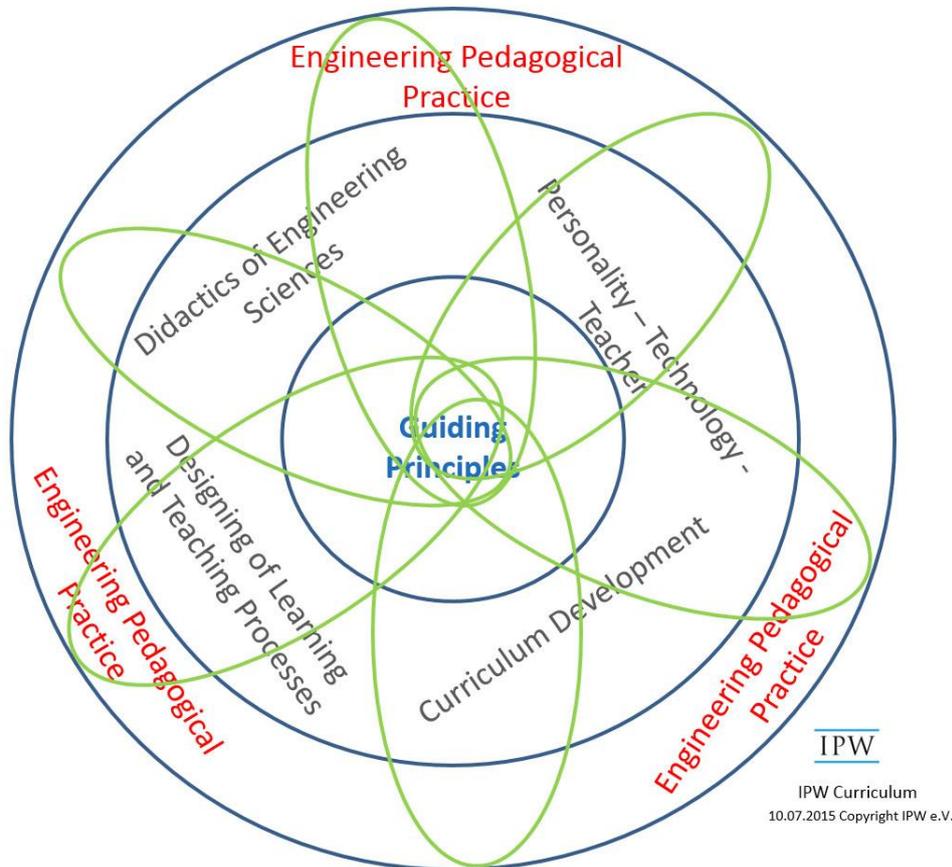


Figure 5: IPW- Curriculum Design - Engineering Pedagogy Theory and Practice (IPW 2016, p.249)

The starting point of curriculum development includes the guiding principles of a scientific, humanistic, and intercultural engineering education.

- “Promoting technical education for a comprehensive sustainable development in the sense of European and external European humanism
- Respecting the diversity of scientific traditions and developments in different cultures - promoting a fruitful scientific exchange
- Importance of practice for the learning process, for the study and in the working world
- Interpersonal relationship as the basis of teaching and learning
- Strengthening the personality of students in the sense of ability to be creative and judgmental as well as a high level of "self-activity"
- In this sense, technical education has a civic, social and cultural perspective.”

(IPW 2016, p.250)

These typical fields of activity of a university lecturer in engineering sciences, the resulting requirements, as well as the demonstrated guiding ideas led to the following modular structure of the advanced training in engineering pedagogy.

▪ “Engineering Pedagogy in Theory and Practice	6 CP
▪ Laboratory and Workshop Didactics	3 CP
▪ Technology Communication (Scientific Writing)	3 CP
▪ E-Learning, Use of Media	2 CP
▪ Aspects from Anthropology, Psychology and Sociology	3 CP
▪ Control and evaluation of learning results in the Engineering education	2 CP
Optional modules	1 CP
▪ Aspects of Ethics in Science and Technology	
▪ Intercultural Competences	

Cross-Section Modules (Option Modules)

▪ Complex Forms of Teaching and Working	2 CP
▪ Didactics of Preparation for the Professional Life	2 CP

Engineering Pedagogical Colloquium at the End of the Curriculum”
(IPW 2016, p.251)

The detailed module manual can be read in IPW 2016 p.255ff.

Comparing the three curriculum drafts of the IGIP, the TU Dresden, and the IPW, we can find similarities and differences. An essential commonality lies in the extent of the further training. The IGIP has defined this as 20 CP and thus created an accepted standard. 200 to 250 hours are recommended for the presence time. The observance of these formal standards was one of the prerequisites for the accreditation of the TU Dresden curriculum by the IGIP International Monitoring Committee.

The IGIP curriculum follows a classical study structure. First, discipline-oriented foundations (pedagogy, psychology, sociology) are taught, followed by selected applications (project work, communication, etc.). The typical fields of activity of a university lecturer and the related requirements are not recognisable in this curriculum. The reason is the openness of the target group. With its former President, MELEZINEK, IGIP has a great radius of influence in Eastern Europe. In Eastern Europe, however, the term "engineering pedagogy" also includes the training of technical vocational school teachers.

The curriculum of the TU Dresden focusses very strongly on the fields of activity of university lecturers in engineering sciences. The qualification objectives were determined empirically through the analysis of activities, requirements, and needs. The developed study structure is therefore very application-oriented, though systematic. It leads from micro didactic questions, including the psychological basis, to the curricular development of courses in engineering education. The target group here is exclusively lecturers of the engineering sciences.

The IPW curriculum also focusses on the target group of teachers of engineering sciences. Although the fields of activity of the university teachers were the starting points of the discussions, they were strongly superimposed by humanistic, ethical, and intercultural aspects. The result is a

very open curriculum, which can be adapted to the needs of the respective university and the respective engineering sciences.

Irrespective of the advantages and disadvantages of the illustrated curricular designs of an engineering pedagogy, the decisive positive fact is the intensive strive for the pedagogical qualification of university teachers. For a long time, the high scientific competence of a professor in their field was considered as a guarantor of quality teaching. Discussions concerning engineering pedagogical qualifications, medical pedagogical qualifications, etc., the establishment of university didactical centres, and the expansion of university pedagogical further training offers are positive signals for a rethinking in this regard.

References

- [1] Anordnung über die Erteilung und den Entzug der *Facultas dicendi* (Lehrbefähigung) Gesetzblatt der Deutschen Demokratischen Republik II 1968 (Nr.127, S.1004 – 1005)
- [2] Frieling, Ekkehart.: *Das lernende Unternehmen.* –Hochheim 1993
- [3] Heidegger, G; Rauner, F.: *Berufe 2000 – Berufliche Bildung für die industrielle Produktion der Zukunft.* Düsseldorf 1989
- [4] Hortsch, H.; Jentzsch, D.; Borchardt, P.: *Umsetzung von unternehmensindividueller Weiterbildung in Kleinunternehmen aus dem Bereich Natur + Umwelt.* Dresden 2003
- [5] *Ingenieurpädagogische Wissenschaftsgesellschaft IPW): Das IPW Curriculum.*
In: Kammasch, G.; Dehing, A.; van Dorp, C. A. (Hrsg.): *Anwendungsorientierung und Wissenschaftsorientierung in der Ingenieurausbildung – Wege zu technischer Bildung.* Referate der 10. Ingenieurpädagogischen Regionaltagung 2016. Siegen 2016
- [6] *Internationale Gesellschaft für Ingenieurpädagogik IGIP: Das IGIP Curriculum Ingenieurpädagogik.* <http://www.igip.org/igip/ing-paed-igip>, 22.10.2016
- [7] Kersten, Steffen: *e-didact - Engineering Pedagogy at Universities in Saxony - A Research and Further Education Project of TU Dresden and University of Applied Sciences Zittau/Görlitz*
In: *Learning and Sustainability . EDEN Conference Dublin 2011*
- [8] Kersten, Steffen; Simmert, Hartmut; Gormaz, Diego: *Engineering Pedagogy at Universities in Chile - A Research and Further Education Project of TU Dresden and Universidad Autónoma de Chile* In: *Expanding Learning Scenarios.* EDEN Conference Barcelona 2015
- [9] Köhler, Marcel; Umlauft, Timon; Kersten, Steffen; Simmert, Hartmut: *Projekt Ingenieurdidaktik an Sächsischen Hochschulen - e-didact. Projektabschlussbericht.*
Dresdner Beiträge zur Berufspädagogik Heft 33, Dresden 2013
- [10] Krempkow, R.; König, K.; Ellwardt, L. (2006): *Studienqualität und Studienerfolg an sächsischen Hochschulen.* (HoF Arbeitsbericht 05/2006).
- [11] Lohmann, H. (1953/54). *Die Technik und ihre Lehre- Ein Forschungsteilprogramm für eine wissenschaftliche Ingenieurpädagogik.* In: *Wissenschaftliche Zeitschrift der TH Dresden 3 (1953/54) Heft 4, S.602-629*
- [12] Wolffgramm, Horst: *Technische Systeme und Allgemeine Technologie.*
Bad Salzdetfurth 1994