Didactics of Engineering Education
Didactic Principles

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Term „Didactic Principle“

Theory

• describes, explains and prognoses

System of assured statements

Method

• directs and regulates human thought and action

System of rules, principles, advices
PRINCIPLE

- Principles for lesson design, beads 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)
**Descriptive Funktion → Theoretical**
Didactic functions describe explanatory contexts in Design of professional instruction.

**Regulative Funktion → Methodological**
Didactic functions act regulative on orientation, execution and control of teacher acts
Didactic Rules

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

- refer to concrete situations
Influence factors of engineering education

- **Economy**
  - Structures in production and service
  - Professional work
  - Demands on labour

- **Science**
  - Matters of research and research methods in engineering sciences
  - Development of techniques and technology

- **Society**
  - Social needs and social values
  - Idea of man in society

- **Learner**
  - Individuals with needs
  - Cognitions of psychology

Demands on engineering education relating to objectives and organization
Ausgewählte didaktische Prinzipien

Work process reference
Academic approach
Methodology and systematation
Education effectiveness
Comprehensibility
Clearness/Illustration
Activity and autonomy
Theory of long waves in the economy according to Kondratieff
nonage

is the inability to use of the own understanding without direction from another person. (I. Kant)

From the convenience to be nonage

„Enlightenment is man's emergence from his self-incurred nonage...“

Immanuel Kant 1784
Academic approach of teaching is, to teach objectively truth in his system for the acquisition of the vocation.

Academic approach of teaching requires to develop methods and techniques of his professional field and of learning.
Methodology of teaching means to teach purposefully on the basis of curricula and other instructions as well as orders.

Systematology of teaching means to arrange the particular academically proven considering methodology in an entirety.
Teaching in a comprehensible way means to design learning conditions for the students, that they can acquire the learning objects with reasonable effort.

- Developmental Psychological Justification
- Motivation Psychological Justification
- Didactic consequences
Theory of intellectual development according to PIAGET

Mental development takes place in a balanced ratio of assimilation and accommodation.

In the process of assimilation external instructions be brought in accordance with the internal structures.

The mental accommodation is the opposite movement towards assimilation. It consists in the variation of the individual and its inner structure by reality.

Developmental Psychological Justification

**Assimilation**

Admission of new experiences

If necessary, modification of the new experience, for consistency with its own knowledge structure

Contradiction-free integration of new experiences in the own knowledge structure (Act schemes)

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**Accommodation**

Admission of new experiences

Changing the internal structure, for consistency with the new experiences

Contradiction-free integration of new experiences in the own knowledge structure (Act schemes)
Theory of achievement motivation by ATKINSON
(Risk choice model)

Achievement motivation

- Claim, appeal of the task
- Probability of success
- Task difficulty
- Moderate tasks
Didactic rules of the principle of comprehensibility

Move

- from Known to Unknown
- from Simple to more Complicated
- from Near to more Remote
- from Easy to more Difficult
Didactic Consequences

Didactic Simplification

- Disciplinary scientific knowledge structures e.g. Engineering, Medicine, etc.
- Vocation-related knowledge structures

Transformation

„Didactic Principles“ / Dr. phil. Steffen Kersten
Which subject-matters of engineering sciences are useful as appropriate matters of acquisition for the respective professions?

→ relation to subject-matters of engineering sciences

System of scientific statements of engineering sciences with professional relation (Theories, laws, hypotheses ...)

System of professional scientific act regulatives (Principles, methods, rules, procedures)

System of professional scientific act standards (Directives, standards)
Didactic Consequences

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)


Criterion for the legitimacy of didactic simplification

- Academic approach must be preserved
- Transition must be possible without contradictions (no unlearning/relearning – recently learned matters must be compatible with matters learned a longer time ago)
Ways of didactic simplification

Redemption (elimination) of secondary statements – Example 1

In the stomach, proteins are denatured by the hydrochloric acid (Denaturation means complete loss of structure), and the inactive Pepsinogen is activated to pepsin. The latter splits about 10% of the proteins in smaller polypeptide chains that are now resorbable.

Simplification:
In the stomach, part of the proteins by chemical processes into smaller Particles decomposed, which can now be absorbed into the blood.

→ Generic Term
Ways of didactic simplification

Redemption (elimination) of secondary statements– Example 2

In psychology, the observation, the experiment, the test and the survey are scientific procedures to win data about an object of research.

Simplification:
In psychology there are different scientific methods of data collection.

→ Generic Term
Ways of didactic simplification

Redemption (elimination) of secondary statements– Example 3

Electrical conductivity is possible through electrons, ions, or p-holes.

Simplification:
Electrical conductivity is possible through moving charge carriers.

Generic Term
Ways of didactic simplification

Indicative redemption (elimination) of secondary aspects/
Partial statements – Example 1

Causes for the development of liver cirrhosis can be a chronic course of hepatitis B or hepatitis C virus infection, autoimmune hepatitis, congenital metabolic diseases (Wilson's disease, pigment cirrhosis), biliary disease or toxic injury by ethyl alcohol.

Simplification:
Among the many possible causes for the development of liver cirrhosis, toxic damage from alcohol in Germany is most common.

Essential sub statements are singled out and pointed to the existence of the another parts of statements.
Ways of didactic simplification

Indicative redemption (elimination) of secondary aspects/
Partial statements – Example 2

In the social pedagogical practice, a distinction the methods of the social community work, social group work and individual social casework

Simplification
The individual social case work represents an important method of social pedagogical practice.

Essential sub statements are singled out and pointed to the existence of the another parts of statements.
Ways of didactic simplification

Indicative redemption (elimination) of secondary aspects/
Partial statements – Example 3

Electrical conductivity is possible through electrons, ions, or p-holes.

Simplification

Electrical conductivity is caused by electrons in the most cases.
There are other charge carriers.

Essential sub statements are singled out and pointed to the existence of the another parts of statements.
Ways of didactic simplification

**Indicative Generalisation**—Example 1

Speed is the differential of the path over the time

\[ V = \frac{ds}{dt} \]

**Vereinfachung:**

Speed is the ratio of distance and time.

\[ V = \frac{s}{t} \]

*(with uniform movement)*

**Transition to a simplified statement with reference to restrictive features**
Indicative Generalisation – Example 2

Simplification:

Veins carry deoxygenated blood to the heart, that is true only in the body circulation.

(Not in the lung circulation)

Transition to a simplified statement with reference to restrictive features

Die Lungenarterien sind hier blau gezeichnet, weil sie „venöses“ Blut enthalten. Dementsprechend sind die Lungenvenen wegen ihres „arteriellen“ Blutes rot dargestellt. [403]
Exercise: group work 3 members 30 min

Find for each method of didactic simplification an example from your subject!
The didactic principle of clarity is directed on the conscious design of perceptual processes in the classroom.

Clearness is a property of subjective images, which as a result of perceptual processes arise, if

- The matter of acquisition has pictorial character
- The matter of acquisition allows connotations to matters already learned
- The linguistic elements already known to the learner
Illustration/Visualisation in Process of Acquisition

by

Graphic matter of acquisition
- self-dependently experienced reality
- demonstrated reality

Non concrete matter of acquisition
- models
- figurative depiction
- schemes

Representational-abstract Matter of acquisition
- oral description of matters of acquisition
- written description of matters of acquisition

Level of Abstraction

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Exercise: group work 3 members 20 min

Which criteria you have to follow to design a ppt-presentation?