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ABSTRACT

A feature of teacher training in Germany is its high degree of professionalization: it is on the same level with other studies, such as medicine. University education includes not only a specialization in technology, but also studies in pedagogy. An essential factor is the close connection with the future professional career, achieved by teaching practice in parallel with university education. This comprehensive approach to teacher training runs the risk, however, that students can later find employment only at schools or similar institutions. Employment as an engineer, for example, is rendered impossible because design work does not take a central position during studies for the teaching profession. There are standards throughout the country for university studies for the teaching professions, enabling graduates to find positions in any of the states. The teacher training program may change, however, as it becomes increasingly necessary to make university degrees compatible throughout the European Community. At present, it is impossible for graduates of universities in other countries to become teachers in Germany because of the state examinations required. (KC)

Theuerkauf, Walter E.; Weiner Andreas

TECHNOLOGY EDUCATION AND VOCATIONAL-TECHNICAL TEACHER PREPARATION IN GERMANY

1. *General conditions for teacher training*

In the Federal Republic of Germany two basic factors determine the principles of teacher training: on the one hand there is the school system, which reveals an almost identical structure throughout the sixteen Federal States, and on the other hand teachers are, since they teach at public schools, subject to the civil service status[1].

The teacher training scheme generally falls into the two phases of university studies and the probation period, during which teachers are candidates for higher civil service after having passed their first state examination.

> University studies is concluded with the first state examination, the examination rules being set forth by the government of the Federal state in question, in collaboration with representatives from universities. These rules have the character of guidelines for the university curricula. Universities and their different departments have to take the examination rules into account in setting up the curricula for their courses.
>
> The training during the probation perriod is a tutorial accompanied by teaching practice at a school. As a general rule it extends over two years and is concluded by the Second State Examination. The responsibility for training and examination rests solely with the authority of the state concerned. During the second phase of teacher training, the candidate more and more often goes into different classes to actually teach. He or she is assisted and given guidance during this phase by an experienced tutor as well as the subject teacher and the head of the seminary.
>
> The Second State Examination comprises a test lesson in the candidate's subjects, a scientific paper, and an oral examination. As the probation period has no links with the university studies, it will not further be dealt with in the discussion below.

To be able to coordinate standards of teacher training beyond the boundaries of the different states, the university regulations are subject to official framework[2]. What is said below for the teacher training in the Federal State of Lower Saxony by analogy also applies to the training schedule in the other states.

2. *The school system in Germany*

The close relationship that exists between school system and teacher training, makes it expedient to start by briefly explaining the school system.

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1 With only a few exceptions, the educational system in Germany is a government-run system, for which the responsibility rests with the different Federal States, and with the Permanent Conference of the Ministers for Education and Culture of the federal German states assuming a co-ordinating function.

2 Educational reform commissions at the Federal level and at the level of the states have prepared a co-ordinated framework for the different subjects. These frameworks have the character of a recommendation.

The educational system in the Federal Republic of Germany is subdivided into the two sectors of general educational and vocational training.

Having been formed in the course of several hundred years and influenced by Humboldt's theory of education, general education aims to provide the cultural techniques, but also to equip pupils with an encompassing and broadly-based knowledge. It finds its concrete shape in dealing with and developing patterns of action that will help develop ones personality and master one's life at present and in the future. Providing a basic education it at the same time lays the foundations for vocational training.

Vocational training is to qualify students for a trade or a specific profession. The two sectors within the German educational system thus have to differ in their curricular and educational approach. For the individual, however, there is no hard and fast dividing line between the two systems. In this connection it should be underlined that general education and vocational training are interdependent and complement one another in their aspiration to help a young person develop his or her own and comprehensive personality.

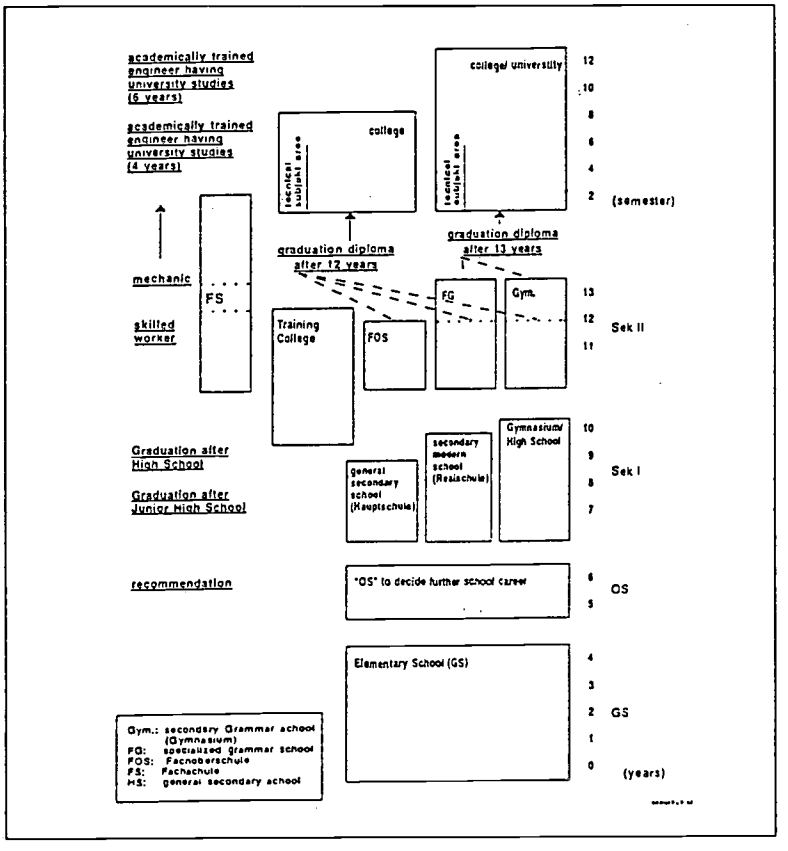

Fig. 1: Structure of the educational system in Germany

General education starts with kindergarten. After completion of the elementary school level (and assessment stage[3]), pupils attend either the general secondary school (Hauptschule), the secondary modern school (Realschule), or the high school (Gymnasium). At the end of general secondary school and secondary modern school, students can finish school with the secundary level I school leaving certificate (confirming completion of the first level of secondary education), which at the same time marks the end of compulsory school education. The Gymnasium on the other hand allows pupils to complete the second level in secondary education (Secundary level II), which is terminated by the school leaving certificate „ Abitur". These two certificates represent the entrance qualification for vocational training or academic studies.

The two secondary levels lead over to the broadly-based Sekundarstufe II education and training system providing vocational qualification[4]. Its principles include those of the dual training (Theuerkauf, Weiner 1993) with the vocational school and trade and industry as

3 In some Federal States the elementary level (primary school, years 1 to 4) is followed by the assessment stage (school years 5 to 7), in which pupils are allocated to appropriate secondary shools.

4 The next higher level following the Sekundarstufe II vocational scheme is the education at the higher technical colleges and universities

participating factors, as well as the college of technology, the continuation school and the vocational gymnasium.

The courses set up at the university level for the teaching profession[5] take a bearing on the objectives and aims of the different types of schools. Courses available are those for

teachers at elementary/ general secondary schools	school years 1 - 9
teachers at secondary modern schools	school years 5/7 - 10
teachers at high schools (Gymnasium)	school years 5/7 - 13
teachers at vocational schools	school years 10 (11) - 13 (14)

The main difference between courses lies in their length, the subjects to be taken, as well as the extent to which basic sciences have to be represented.

3. *The structure of teacher training*

Teacher training is to qualify students for their future professional life.

University studies taken up by future teachers at schools of general education comprises the basic sciences, the special sciences and practical experience. A minimum of two different school subjects have to be studied. The different elements are integrated to form a comprehensive course of studies for the teaching profession.

The basic sciences to be studied comprise the science of education, paedagogic psychology, and, as optional subjects, philosophy, sociology and the political sciences. The aim of these subjects is to impart the theoretical basis and the methods of planning and realizing teaching processes. Studies in the school subjects chosen fall into the scientific and didactic aspects of the relevant subject. While the scientific component aims at the subject-related knowledge or the special studies, the didactic component

Type of school	secondary general school	secondary modern school	High school	vocational school	
Subject	Hours/Week/Semester				
Paedagogic of the type of school	20	14	14		
Paedagogical Psychology	12	10	12		
Philosophy				30	30
Sociology	10	8	12		
Political Science					
First Subject	30 (15)	45 (10)	60 (6)	95 (6)	36 (6)
Second Subject	30 (15)	45 (10)	60 (6)	45 (6)	45 (6)
Third Subject	12 (12)	14 (6)	6	0	
Subjects for first grader(Read/Write)	6	-	-	-	
Total Hours/Week/Semester	114-120	136	163	180	111
Praktical Training					
In-shool training	4 -5 W.	4 -5 W.	4 -5 W.	3 W.	3 W
Social/Incustrial practical training	4 W.	4 W.	4 W.	52 W.	52 W.
In-school training of the studied subject	4 -5 W.	4 -5 W.	4 W.	5 W.	5 W.

A course of 2 hours per week and semester maintains about 30- 32 hours (1 hour of a course means 45 minute)

Fig. 2: Table of subjects and the length of the degrees[6]

[5] Teacher preparation for special schools will not be dealt with here. Above and beyond that some German states know the teaching position for Sekundarstufe I, combining the teaching positions for main and middle schools.

[6] The following should be noted:
- future primary school teachers have to inscribe for lectures for first-grader teaching

addresses the planning, realisation and evaluation of the subject-related teaching process.

The practical experience to be gathered during the time at university falls into the two categories social or industrial experience and subject-related teaching experience. The former is to give students a first-hand impression of non-school sectors, while the latter provides first experience in the role of the teacher. This practical work provides the link between the theoretical and practical approach and is to allow students to actually apply newly acquired knowledge, but also with the benefit of the practical experience gathered to take a new look at the envisaged course of studies.

University studies are subdivided into the basic studies and the main studies. The basic studies are to impart a broadly-based basic knowledge, while the main studies mean specialisation and a deepening of knowledge. The share of these two components in the university studies in general varies between 40 and 50%. In the course for students qualifying for the Gymnasium and vocational schools, the basic studies are terminated by an intermediate examination.

To be able to assume the responsibilities of a class teacher and to satisfy the requirements of the school divisions[7] there are prescribed corespondent combinations of subjects

4. *Teacher training for the subject 'technology' at schools providing a general education*

Technology education forms part of the syllabus at any type of school imparting general education and at all levels, be it in the form of technology teaching in its own right or as part of general subjects (Sachunterricht) or of the interlinked subjects of work, economic and technology (Arbeitslehre).

University studies comprise scientific, didactic and practical components, which because of their general character go beyond the mere teaching profession.

4.1 The scientific component

A basic technical understanding refers to artefacts and technical methods and processes as well as their interrelationship with economic, social and ecological conditions and implications. Future teachers thus have to be enabled to deal within a scientific context with technical aspects and processes against the background of the above conditions and implications.

The scientific component has to take a bearing on the systems of mass, energy and information transfer as well as socio-technical systems. Integrated are processes and methods of design engineering as a major characteristic of technical processes.

Fundamentals
Mathematical and physical principles of technical systems
Principles of the humane discipline: philosophy and the history of technology
General technology
Design engineering

- future primary, secondary general school and secondary modern school teachers have to study two subjects as well as a third subject covering only didactic elements

7 The school division work/economics/technology comprises the subjects economics, home economics and technology, while the mathematical/scientific division comprises mathematics, science, informatics and technology.

Production systems
Basic processes of production and process engineering
Product design and development

Electrical and mechanical systems
Electrical and mechanical structures
Systems of energy conversion and energy transfer
Electric drive systems

Systems of information technology
Basic control systems
Systems of data processing and transmission
Process data processing

Socio-technical systems
Urban planning and urban traffic planning with due regard to ecological aspects
Industrial systems and their consequences for a changed qualification pattern

The different fields listed here have to be regarded as general issues. Basic scientific studies concentrate, among other aspects, on the „general technology", i.e. the processes and methods involved with the basic categories mass, energy and information, while students in their main studies go into the depth and specialise in such complex systems as refrigerating plants and heat pumps.

4.2. *The didactic component*

The didactic component as part of teacher training deals with the selection of the scientific elements and the planning, realisation and evaluation of learning processes in the subject 'technology'. From this, the following fields can be derived:

Principles of the teaching process
Didactics as part of technology teaching
Teaching and learning methods as part of technology teaching
Development of curricula and lesson organisation as part of technology teaching

4.3 *The interdisciplinary component*

University courses provide for interdisciplinary lecturing in the field economics, work sciences and technology for students qualifying for teaching functions at elementary and main schools as well as middle schools[8]. Basically they comprise the organisation of interdisciplinary scientific or curricular projects. For future high school/Gymnasium teachers subjects can primarily be science or informatics.

4.4 *The practical component*

An essential aspect of teacher training is to prepare future teachers for product-related functions at the school, which have to be realised with due regard to the relevant safety regulations. As part of work experience schemes in mechanical engineering students are instructed, among other things, in the use of computer-controlled machinery. CAD systems are employed for design functions and components of computer-integrated manufacturing are used in laboratory tests as part of production engineering schemes.

8 Universities reveal different degrees of interlinking of the subjects economics, technology, home economics.

4.5 *Features of the First State examination*

Successful participation in lectures and seminars is verified by certificates, a certain number of which having to be produced to be able to register for the first state examination at the end of one's studies. The examination consists of an oral and/or a written part in all the subjects, as well as a practical/methodical examination and an examination paper.

5 *Teacher training for vocational schools in the metal working field*

Below will be discussed the training scheme for teachers at vocational schools specialising in metal working. To begin with, the sphere of activity will be outlined.

Teaching functions at vocational schools fall into the following four sectors:

industrial/technical
home economics/nursing
agricultural
commercial

The industrial/technical sectors include civil engineering, electrical engineering, design and metal working.

These sectors are covered by different types of schools, a prominent position being taken, because of the sheer number of students attending this school, by the vocational school, which forms part of the dual system of vocational training in the Federal Republic of Germany (Theuerkauf/Weiner 1993). Within in this system, industry takes care of the more practice-oriented elements of training, while the vocational schools are responsible for the theoretical knowledge. Students following the dual training scheme complete school with an examination for skilled workers.

Another type of school that has a role to play is the college of technology, which is a two-year school training technicians who are enabled to perform a wide range of functions in any technical area. In their capacity as middle managment executives they hold positions somewhere between the skilled worker and the engineer. With their final examination technicians prove that they are qualified to assume responsibility for technical tasks within certain fields.

The training schedule for teachers at vocational schools in the Federal Republic comprises practical work in industry as well as the first and the second phase. The metal working sector is to serve as an example here to illustrate the principles of teacher training for vocational schools. The training can proceed in the form of a comprehensive course of studies or in the form of a supplementary course, the latter requiring that students have graduated (as a Diplom- Ingenieur) from a higher technical college in the special field chosen (Weiner 1993).

5.1 *The practical component*

To be able to register for the first state examination students have to prove that they have completed a one-year practical work in industry. This practical work is to allow them to acquire knowledge, skills and experience in sectors of basic vocational training, and they are to be given a general idea of the in-company training scheme.

Students are thus to acquaint themselves with the basic work methods and with the knowledge that needs to be acquired during the vocational training scheme.

The practical work can also be considered as having been completed when students prove to have run through an in-company training programme in a field generally accepted as trainee trade.

5.2 The scientific component

The basic studies for the metal working specialisation covers when studies in the form of a comprehensive course of studies eight semesters plus two examination semesters during the three phases basic studies, main studies, examination phase. The basic studies cover semesters 1 to 4, the main studies semesters 5 to 8. The basic studies end with the intermediate examination, the main studies with the first state examination. As regards the scientific component of their studies, students attend lectures together with the students following an engineering course.

During the basic studies in production engineering, the following subjects need to be covered:

Mathematics for engineers
Technical mechanics
Principles of electrical engineering
Physics
Programming exercises
Components of machinery
Material science
Principles of production engineering

The following items show where the emphasis lies during the main studies in production engineering:

General mechanical laboratory
Laboratory of the studied subject
Production processes
Production engineering or technology of metal forming
Construction materials or material science,
or industrial metrology and quality assurance,
or automotive engineering,
or principles of measuring and control .

Teacher preparation by supplementary studies require only the subject mechanics from the basic studies but nearly the whole subjects of the main studies except the general mechanical laboratory and the laboratory of studied subject

5.3 Didactic components

The didactic component of studies has similar intentions as in teacher training for schools of general education. The training programme for teachers at vocational schools with the specialisation metal working covers three seminars that are based on each other. Students start in their sixth semester with selected text work, on the basis of which lessons are planned in detail in the seventh semester. The seminar in the didactics of mechanical engineering II provides for preparation, support and follow-up work for the second practical teaching phase in metal working.

The subject didactics of mechanical engineering covers the following courses:

Principles of technical didactics
Didactics of mechanical engineering I/II

5.4 The First State Examination

Like the course of studies for teachers at schools of general education, the first state examination comprises the dissertation, the supervised task, and the oral examinations.

6. Summary

One feature of teacher training in the Federal Republic of Germany is its high degree of professionalisation. As regards the degree taken, it can thus be said to be on the same level with other academic studies, as for instance the medical studies. University education is not only based on a specialisation in technology - which would also be conceivable for a teacher of technology - building up on which are then paedagogic/didactic studies.

An essential factor is the close connection with the future professional functions, which is achieved by teaching practice in parallel with university education. This prevents university education from standing out from and remaining separate from the real situation at school; also, students are thus allowed to reflect on the reality at school and their studies.

This comprehensive approach of teacher training bears the risk, however, that students can in their later life find employment only at schools or similar institutions. Employment as an engineer is rendered impossible as in particular the aspect of artefact design does not take a central position during the studies for the teaching profession.

Agreements reached across the different federal states set a general timescale for the university studies for the teaching profession at the different schools, and the guidelines set forth for the school subjects that may be taken provides for a certain coordination of the contents. Because of these standards, which are based on the requirements of the educational system, graduates meet the requirements that enable them to find employment as a civil servant in any of the federal German states.

As it is intended to harmonise university degrees throughout the European Community, it remains to be seen whether the teacher training scheme can persist as it is. The basic principle of state examinations makes it impossible for graduates from other European countries to be taken on as civil servants in the Federal Republic of Germany.

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TECHNOLOGY EDUCATION AND VOCATIONAL- TECHNICAL TEACHER PREPARATION IN GERMANY

Phases of Teacher Training

Phase 1: University Studies
Duration: 3.5-5 years

University studies are concluded with the first state examination, the examination rules being set forth by the government of the Federal State in question, in collaboration with representatives from universities. These rules have the character of guidelines for the university curricula. Universities and their different departments have to take the examination rules into account in setting up the curricula for their courses.

Phase 2: Probationary Period
Duration: 2 years

The Probationary Period is a tutorial training accompanied by teaching practice at a school. As a general rule it extends over two years and is concluded by the Second State Examination. The candidate more and more often goes into different classes to actually teach. He or she is assisted and given guidance during this phase by an experienced tutor as well as the subject

Sectors of Teaching Funktion at Vocational Schools

Home economics/Nursing
Agricultural
Commercial
Industrial/Technical — electrical engineering
mechanical engineering — production engineering
automotive engineering

Subjects of Teacher Training (Technical sector)

Basic studies (Mechanical engineering; - Semester 1-4)

Scientific Components

Mathematics for engineers
Technical mechanics
Principles of electrical engineering
Physics
Programming exercises
Components of machinery
Material science
Principles of production engineering

Intermediate Examination

Main studies (Emphasis production engineering;-Semester 5-8)

Scientific components

General mechanical laboratory
Laboratory of the studied subject
Production processes
Production engineering or technology of metal forming
Construction materials or material science,
or industrial metrology and quality assurance,
or automotive engineering,
or principles of measuring and control .

Didactic components

Principles of technical didactics
Didactics of mechanical engineering I/II

First State Examination

Teacher preparation by supplementary studies require only the subject mechanics from the baasic studies but nearly the total subjects of the main studies except the general mechanical labbaratory and the labaratory of the studied subject

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