

GRADUATE LEVEL EDUCATION

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Summary

The integration of teaching and research is essential for high-quality graduate level education. An improved system for doctoral training may need to be created. A shorter period of studies and thesis preparation as well as broader subject areas may be very useful. The German model of research training (Graduiertenkolleg) should be examined and evaluated in other countries. In this model, intensive guidance and contact with advanced research is offered to small groups of doctoral students by experienced professors from different disciplines and different universities, and the underlying research work cuts across various disciplines. Eminent professors engaged in postgraduate training should be given the possibility to set up their own groups of emerging new talents and encourage them to apply for external funding. Universities should create pools of posts for postdoctoral scholars, because temporary employment should be favored over grants and scholarships. This is particularly true for women interested in research careers.

1. Introduction

The almost explosive development in information technologies has more than ever

before made graduate level education a truly global issue. With the USA the most dominant economic power after World War II, it has not surprisingly been common in many countries in Europe to try to reshape their doctoral training so that the structure of their higher education programs are more like those in America leading to a doctorate (Ph.D.). For quite a while there was a gradual transition in Europe from the Humboldtian university tradition towards the Anglo-Saxon model, but so dramatic a change in a historical tradition is not made overnight simply by changing the titles of degrees. Nor is it possible to copy the principles of, for example, a North American Ph.D. training program and superimpose them upon a national higher education structure developed over centuries.

European universities have shown a surprising capacity to survive over centuries and have demonstrated that their basic structure, organized around the various basic disciplines, is a fruitful way of achieving research training in basic methodologies to the highest level. The societies of today require, however, that knowledge be combined across disciplines, between research groups, faculties, universities, and to a greater extent between universities and industry in order to solve increasingly complex problems. Thus, the future research questions and programs require a flexible and dynamic composition of their research training structures with a truly international routing. Several universities are trying to adapt to this changing world, thereby running the risk of destroying or at least weakening what they have historically been very good at.

Today the major problem is not to increase the volume of formalized doctoral training, but rather to ensure that the quality of doctoral training is maintained and strengthened, while at the same time trying to experiment with different types of graduate schools and different forms of inter-university collaboration across borders. Moreover, it is essential that industry-university collaboration in research training is facilitated with due respect to the different cultures operating within these two sectors of modern society.

To avoid a trend towards diminishing quality, it seems appropriate, in addition to Ph.D. training, to focus more on the universities' future role in what is designated postgraduate "professional training" in general.

2. Peculiarities of Graduate and Postgraduate Education Systems in Western Europe and the USA

2.1. Current Initiatives

Most European countries have realized the need for rapid growth in academic personnel with a doctoral degree based on formalized research training. Moreover, the European Commission (E.C.) indicated that about 10% of resources in the proposed V Framework Program were assigned to the horizontal program entitled "Human Resources." This development truly reflects the acknowledgment that the economic growth and technological development of European societies in the foreseeable future will depend on to what extent the member states have a highly competent and academically well-trained generation of young scientists available.

There is little doubt that the driving force behind the rapid increase in the number of

Ph.D. students throughout Europe is the gradual increase in competence required when entering a university career. In the Nordic countries, for example, it has become necessary to have a doctoral degree in order to start a permanent career at universities in Norway, Sweden, and Denmark, whereas Finland appears to retain a more flexible situation. Moreover, in Denmark a new career structure has been established for all public research institutes outside the universities. Recruitment for junior research positions at these institutions now requires a Ph.D. The universities are still the predominant patrons of Ph.D. trained personnel, but the need for industry to become involved in research training and recruit staff with a doctoral background is apparent. In the technical sciences in, for example, Denmark about 50% of all Ph.D.s are finding employment in industry. An individual who wishes to pursue a career in industry and industrial research necessarily must have a research training background identical to that required to follow an academic career at a university. Industry is not interested so much in the degree per se as in producing highly qualified, competent, flexible, and mature young people as early on in their life career as possible whom industry can then train and develop. Of course, such training should be done in close collaboration with highly competent research groups, often located at universities, but we shall probably see in the near future a more flexible and dynamic research training structure grow out of the demands and needs of industry.

The policies today being developed in many European countries have largely been inspired by practices in the United States, and in two distinguishable ways. The first has been the degree structure, with its clearly demarcated spheres of undergraduate and graduate education, the latter divided into a master's phase and then, finally, work towards Ph.D. More recently, it has been the organization of graduate studies in the top American universities that has attracted attention in Europe. The model of the American graduate school has inspired many current initiatives, including those in France and Germany, which are described below.

It is interesting to recall in this context that American Ph.D. research training was itself a deliberate late nineteenth-century borrowing from Germany. Until the late 1870s, German universities were more or less the only institutions in the world in which training in scientific or scholarly research was available. When American academic institutions began training professional researchers, from the 1870s, they adapted the German practices to their own liberal values in training college teachers. Improvisation and adaptation to existing institutional values were initially stressed. The formal training component of American Ph.D. education, today so much admired in Europe, has its roots in the attempt to assimilate graduate to undergraduate work. The emerging practice of American institutions was by no means uncontroversial. The first graduate students, concerned at the variable quality of the training they received, organized themselves in the 1890s to press for improvement and the regulation of graduate programs. Later eminent scholars such as William James and Thorstein Veblen expressed doubts as to whether serious scholarship and mass education could be reconciled.

Recent American practices, though a source of inspiration, have not been taken over unthinkingly. This can be seen in the way in which different European countries have remodeled the structures of their degrees. In many European countries university

education traditionally lasted six or seven years, its termination marked with a degree regarded as comparable to the Anglo-American master's degree. The doctoral dissertation was then prepared in the course of a scientific employment, and was not seen as part of education or training. Many Western European countries have sought to reduce the length of initial study, and to formalize what is not seen as "doctoral training." In the Netherlands this has been done by reducing the time in which students are permitted to earn their first degree (the doctoraal), and by trying to ensure that the doctorate is obtained in four years. Dutch universities continue to offer these two distinct degrees. Other countries have proceeded quite differently. For example, in both Denmark and France a shorter research degree was introduced in parallel to the traditional doctorate. In Denmark this was originally called the "license," but since 1984 it has been called a Ph.D. In both Denmark and France this shorter doctorate has become the doctorate. In Denmark, the long first phase was also divided up, so that a bachelor's degree is now available after three or four years, and a master's degree after five or six. France introduced two kinds of qualifications intermediate between the normal end point of university studies and the doctorate: a professional specialization (Diplôme d'Études Supérieures Spécialisées, or DESS) and a research specialization (Diplôme d'Étude Approfondie, or DEA). The latter was made obligatory for entry to Ph.D. research.

The research training systems of Belgium, France, Germany, and the Netherlands are all in a process of change. In each of the four countries the attempt is being made to adapt deeply rooted attitudes and expectations, long-established organizational forms and traditions, to what now seem to be the experience of efficiency and international competitiveness. In no country is there universal agreement over the decoupling of research training from its traditional academic function, or the organizational consequences of such decoupling. Moreover, differences in attitudes correspond in some measure with distinct disciplinary cultures and labor market circumstances. Some peculiarities of graduate and postgraduate systems are described below, with special emphasis on the French and German experience.

2.1.1. France

The minimum requirement for admission to a university is the baccalauréat, awarded on completion of secondary education. Holders of the baccalauréat can choose from a wide variety of higher education courses of different levels, with different degrees of selection along the way and leading to different interim qualifications. For entry to the prestigious grandes écoles an additional classe préparatoire, leading to a competitive entrance examination, is required. As is well known, France has a highly differentiated higher education system in which the grandes écoles (which until 10 years ago did not prepare graduate students for the doctorate) occupy an important place.

Students complete a general and a more specialized period of higher education, which may be followed by a third period of one year's postgraduate training. There are two quite distinct types of third phase training available: a professional training leading directly to the labor market and offering the DESS and a preparation for research, leading to the DEA. Students wishing to enroll for the DEA must have a maîtrise (master's) degree or an engineer's degree. Students holding a diploma at a comparable

level (four or five years of higher education) may also request authorization to enroll. A DEA is a prerequisite for commencement of doctoral research, and the DEA system is seen as the great strength of French postgraduate training. (In exceptional cases this rule may be waived where applicants already have research experience.)

To be able to offer a DEA in a given specialty, a university or grande école (or combination of institutions) must submit a proposal to the Ministry of Education and have its proposal accepted. Applications have to be very detailed, including both quantitative data and presentation of the pedagogic and scientific content of the proposed DEA. Acceptance is for fixed period, usually two or four years. Every two to four years, expert committees appointed by the Minister review the quality and results of the DEA functioning in their fields. The size of individual DEA (which might be compared to master's programs in the USA) varies enormously: some have as many as 150 students, others as few as five. Students accepted for a DEA are eligible for scholarship (about F 900 per month in late 1999).

To be eligible for a doctoral course, students must already have a DEA, which provides an introduction to research methods as well as further theoretical preparation. Approximately 40% of DEA holders in fact go on to a Ph.D., a figure regarded as problematically low. The recommended time for preparation of a doctorate is from two to four years.

In 1984, as a part of a reform of postgraduate research training designed to give the French doctorate more international appeal, the following measures were introduced. Universities would henceforth have the right to award doctorates themselves in their own name (instead of their being awarded on behalf of a State body). Universities were required to group their DEA/doctorate and DESS programs to relate their postgraduate teaching and research orientations and expertise. In particular, only where an adequate *groupe de formation doctorale* existed would a university be allowed to offer the DEA. Such a *groupe* might well involve research teams not formally part of the university (e.g. Centre National de la Recherche Scientifique [CNRS] laboratories): the essential thing was to ensure an adequate research environment. In addition, new regulations also established that to be eligible to supervise doctoral research, scientists must be officially regarded as equipped for this responsibility: they must have the *habilitation à diriger la recherche*. (Unlike the German *Habilitation*, this was not made dependent upon the preparation of new dissertation. The idea was that candidates' scholarly/scientific work would be examined on behalf of/by a special board established at the institutional level.) Students beginning work on their doctorates are now eligible for a number of scholarships. Unlike the scholarships available to DEA students, however, doctoral scholarships are not provided through normal educational channels. Research scholarships (worth around F 7000 per month in late 1999) are made available principally by the Ministry of Research. It is important to note that scholarships are allocated to university departments or programs (*equipes d'accueil*) in which the research is carried out. The *Direction de la Recherche et des Études Doctorales* of the Ministry of Education enters into an agreement with the specific *equipes d'accueil*. Quotas can thus be used as an indirect form of labor planning (with numbers highly biased towards the hard sciences) as well as means of quality control (through revising quotas). Hitherto, scholarships have typically been awarded for two years, but this is

gradually being increased to three years. Scholarship holders may supplement their incomes by securing additional appointment as university teaching assistants, within a competitive scheme operated by the Ministry of Education. Teaching duties are typically one-third of the duties of a normal staff member. It is up to the head of the department or program to award scholarships to individual candidates.

As is well known, the CNRS plays a major role in French sciences. Since CNRS laboratories often have a multidisciplinary approach rare in the universities, there is a certain complementarity, and in the natural sciences at least CNRS and university groups are often highly integrated. It is very common in these fields for junior research employees to be preparing their doctorates. In this way, the CNRS also plays a major role in the support of doctoral training. Other research institutions, such as the Institut National de la Recherche Agronomique (INRA, the French Institute for Agronomy Research), and the Institut National de la Santé et de la Recherche Médicale (INSERM, the French Institute of Health and Medical Research), play a similar though more limited role. In many cases, a directeur de la recherche or a directeur de thèse (research director or supervisor) at a non-university research institute will also hold a university appointment. The work preceding the writing of a thesis can therefore be done at various research institutes, though the thesis must ultimately be defined in a university. About 6000 theses are submitted each year in France; the preparatory work for about 500 of these is done outside the university. The average number of theses submitted from a DEA has typically been about five, and this is regarded as unacceptably low.

Écoles doctorales (doctoral schools): Although the existing system, and particularly its grounding in the DEA, is seen as successful, a number of problems exist with subsequent doctoral training. Some of these are specific to certain disciplines. For example, in fields like computing and management, it is felt that too few of the best students stay on to work for their doctorates. By contrast, in law and medicine the volume and quality of university research is felt to be problematic. Finally, the rate of completion, especially in social sciences and humanities, is again extremely low (though this is felt to be partly attributable to the high share of foreign students, many of whom return home without completing their theses). Recent proposals to establish doctoral schools have been motivated by a number of related concerns. One, reflecting in part pressure from industry, was a commitment on the part of government to double the number of doctorate holders within five years. This resulted in a rapid growth in the number of scholarships being made available. There is also concern at the quality of the training: the lack of supervision and formal instruction, and the lack of formal seminars in which research students participate.

In September 1990, inviting universities to submit proposals for DEA for the years after 1991, the Ministry of Education referred to the development of écoles doctorales to provide more structure for research training. Universities were invited to consider grouping together their research and teaching units working in an established discipline or on a common theme. Such doctoral schools would have to have a different structure than a DEA for, whilst a DEA could in principle involve various collaborating institutions, a doctoral school would be based in a given institution. Collaboration would in any event be limited to physically proximate institutions. Universities were told that DEA proposals formulated “in the spirit of the doctoral school concept” would

receive financial advantage.

The main goal of the new schools would be to coordinate the efforts of research teams working in the same discipline, to improve the quality of supervision, to raise competition within and between universities, and to compensate for the excessive specialization of a typical Ph.D. Thus students working in a unit associated with one DEA would have access to courses given in their university but in a different DEA, through the medium of the school.

A recent report recommended a rather liberal definition for the *école doctorale*. A special accreditation committee should decide upon each application to establish a school. The minimum number of doctoral students required at an *école doctorale* was estimated to be 40 (guided by at least 10 senior researchers). It should remain possible to train doctoral students without participating in *école doctorale*.

Discussion on how the new schools are to be structured continues. There are seen to be two possibilities. One would be to group DEA in a single institution into a small number of doctoral schools. A second possibility would be to simulate integration between DEA working in the same field, and located reasonably near to each other.

2.1.2. Germany

Traditional Germany university education, in which many years of study were divided between various universities and terminated only by the doctoral degree, is long gone. Today, the formal duration of study for the diploma is eight to nine semesters, or four to four-and-a-half years: in reality students typically take six or seven years. As in France, growing numbers of postgraduate specialization courses were established in German universities in the 1990s. There are now about 500. Permission to begin a new *Aufbaustudium* (graduate course) or other similar course has to be obtained from the responsible Land Ministry of Education. As in France, this growth has been fuelled both by labor market factors and institutional interests. According to one commentator, German students may be inclined to use postgraduate courses as a “parking place”: awaiting an academic opening of another kind (for example, in professional training). Perhaps most fundamentally, one must refer to the continuing failure of attempts to reduce the length of (undergraduate) studies. In a climate in which efficiency and success rates as a proof thereof are emphasized, it made sense to postpone more complex elements of the degree (specialized study, interdisciplinary project work, and preparation for complex professional tasks) to a postgraduate phase.

Only universities (*Universitäten*, *Technische Universitäten*, *Technische Hochschulen*, and *Gesamthochschulen*) are entitled to award doctorates, with each faculty responsible for its own detailed regulations. The average age at which doctorates are obtained is 31.5 years. The percentage of graduates going on to obtain doctorates varies from under 10% (in theology, psychology, education, law, and economics, for example) to well over 50% (chemistry, medicine).

Work towards a doctorate in Germany is generally not organized as postgraduate education: there are few, if any, course requirements. For the most part, doctoral

research is funded through one or other kind of university appointment entailing teaching or research services and not specifically intended for support of research training. Appointment as a wissenschaftliche Angestellte (scientific employee) may be on the basis of a university position or alternatively it may be based on external research funds (Drittmittel). Such a post may be held for up to five years, within which time the Ph.D. dissertation is to be written. A minority receives fellowships from programs funded by regional governments. A study conducted between 1983 and 1985 and based on interviews carried out in five academic institutions suggests that, in general, funding on the basis of university employment was viewed by most as the ideal. Fellowships, interviewees felt, did not last long enough and the funding levels were too low. The majority had obtained their employment through a professor they knew (a situation some commentators have seen as leading to excessively dependent relationships, and to “cliques and provincialism”). It does not appear that employment income of this sort is more available to male than female trainees, or (reflecting the supply of external funds) more to those working in the natural sciences than to those in the humanities. On the whole, academic opinion in Germany nevertheless tends to favor this mode of support above fellowship schemes. It is often stressed that university employment is integrative: it counters isolation.

Young scientists appointed by professors to posts funded by the department seem to have no problem of isolation. They necessarily play an active role in the teaching and research activities associated with the Chair. For those funded from external sources, matters may be different. Employment on external funds usually involves working on a theme, possibly within a larger project, which subsequently becomes the subject of their dissertation. Whilst integration into an intellectual and organizational context can take place through such broader research projects, much depends on the specific research environment. A large externally supported research program (for example, Sonderforschungsbereiche (special research areas) supported by the Deutsche Forschungsgemeinschaft (German Research Council), or DFG) provides a very different environment from that a lone researcher may endure. Isolation is generally a problem of trainees in the social sciences and the humanities.

The study referred to above suggests that the average time elapsing between completion of the first degree and receipt of the doctorate (Promotionsdauer) is 5.2 years (of which 4.1 years' full-time work are on average necessary for the thesis itself). A correlation is suggested between frequency of contacts with supervisors and the time needed to prepare the dissertation. Unsurprisingly, the less the supervision received (and about half the trainees see their supervisors once in three months, at most), the greater the dissatisfaction. On the other hand, much of the dissatisfaction uncovered in the study had to do with external matters: family, employment. Many trainees were fearful regarding their future. Even though many (about half) thought principally in terms of a job outside the university, many were afraid of unemployment.

After promotion, employment as a Hochschulassistent (university assistant) is possible for a period of up to 2 x 3 years. In this period the Habilitation (thesis essential for ultimate appointment to a professional post) has to be prepared.

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Biographical Sketch

Yu.D. Tretyakov was born on October 4, 1931, in Rostov on the Don River in Russia. He graduated from Rostov State University with an M.Sc. in 1954 and gained a Ph.D. (1958) and a D.Sc. (1965) from Lomonosov Moscow State University. He has held the positions of research chemist, lecturer, professor, and laboratory head at Lomonosov Moscow State University. He became head of the Inorganic Chemistry Division in 1988, dean of the Higher School of Materials Science in 1991 at the same university, and director of the Laboratory of Chemical Synergistics (Kurnakov Institute of Russian Academy of Sciences) in 1994.

Dr. Tretyakov is a Corresponding Member (1984) and a Full Member (1987) of the USSR (now Russian)

Academy of Sciences; National Representative (1987–1990) and Titular Member (1990–1993) of the IUPAC Committee on Chemical Education; Member of the IUPAC Coordination Committee on Chemistry and Advanced Materials (since 1991); Professional Member of the Academy of Ceramics (since 1987); Coordinator of the National Program in Chemistry and Technology of the HTSC (since 1987); and Member of Academia Europaea (since 1999). He received the Kurnakov Prize in chemistry from the USSR Academy of Sciences, the Avizenna Prize of the Tajikistan Academy of Sciences, and the Lomonosov Prize (twice) from the Lomonosov Moscow State University. He has been president of the Russian Materials Research Society since 1992. His publications number 10 monographs and textbooks, he has 50 national patents, and has published over 500 research papers. Dr. Tretyakov was chief editor of the Journal of the Russian Mendeleev Chemical Society (1990–1995) and a member of the editorial boards of Journal of Solid State Chemistry, Ceramics International, the Russian journal Inorganic Materials, Russian Journal of Inorganic Chemistry, and the Russian journal Materials Science.

He was visiting scientist at Max-Planck Institut fuer Physikalische Chemie (1964/1965), at Ohio State University and Pennstate (1967/1968), and at the Australian National University (1974/1975). He was a visiting professor at Waseda University (Tokyo 1980/1981, 1994), at Havana University (Cuba 1983), at Humboldt University (Berlin 1990), and at POSTECH and KAIST (Republic of Korea 1993, 1995)