# The learning approach to doctoral students' education at the Faculty of Environmental Engineering, CUT

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ABSTRACT: By analysing the programme of PhD studies, the author describes the learning approach toward PhD students' education. The Faculty of Environmental Engineering at Cracow University of Technology (CUT) in Kraków, Poland, runs a four-year PhD programme that prepares students to obtain their PhD degree in technical sciences in the discipline of environmental engineering. Studies are conducted on the basis of the doctoral curriculum established by the Faculty Board. The framework of studies and recruitment procedures are defined in the regulations. The head of the doctoral programme establishes the courses, detailed scope of research and other responsibilities of PhD students in line with the recommendation of a supervisor. This article describes the PhD students' education adopted at the Faculty of Environmental Engineering at CUT. Recruitment procedures are described in the first part. In the second part of this article, the author presents a comprehensive overview of the PhD education, including the framework of studies, the curriculum and international cooperation. In the third part, a presentation concerning the forms of financial support and scholarships for PhD students is given.

Keywords: PhD studies, education, curriculum, environmental engineering

## INTRODUCTION

In recent years, due to the three-stage system of education (Bachelor, Master, PhD) at universities, the number of open PhD studies has increased. Therefore, universities have to educate a more diverse group of students who want to graduate with a PhD degree. Preparing the next generation of PhD students who will have a significant impact on the global environment requires efforts across many levels inside and outside the university, e.g. the students need to know how to do the research, be competent writers, speakers and team members, and present research goals and results effectively.

The competencies expected from young researchers, which may be necessary during their development and in the future, are as follows:

- Traditional academic research competencies for successfully conducting and publishing research;
- Professional competencies for guaranteeing appropriate local and global dissemination of research;
- International competencies for establishing scientific collaboration with researchers from other countries.

As a consequence, the preparation of PhD students results in the need for many more competencies than the traditional academic ones [1]. Future employers (e.g. academy, business, government) might, then, be looking for highly-qualified graduate researchers who are able to bring new ideas into their workplace.

With a complex learning approach, Cracow University of Technology (CUT) in Kraków, Poland, focuses on educating highly qualified PhDs who can face academic and industry challenges. It supports the progress of PhD students giving them opportunities to develop their scientific interests and supporting their participation in national and international scientific exchanges. The CUT also serves the world of science by solving technical and technological problems and by implementing scientific studies.

The Faculty of Environmental Engineering at CUT in Kraków, Poland, runs four-year PhD studies, which prepare for obtaining the PhD degree of technical sciences in the discipline of environmental engineering [2]. Studies facilitate conducting independent research, scientific collaboration in research teams, participation in the scientific community in the country and abroad, preparation of PhD student research publications, implementation of studies programme

involving compulsory and optional classes and apprenticeships, pre-doctoral examinations and the preparation of the PhD thesis under the direction of a supervisor [3].

By realising its goals CUT creates an international space for research and education. It develops multidirectional studies and research, combining technical science with mathematical, physical, biological, environmental, economic sciences, using information technologies. It also fosters students' independence, giving them a strong basis for working in the market, which is constantly becoming more modern [2].

## RECRUITMENT PROCEDURES

Those applying to register as PhD students in environmental engineering must hold either a Master's degree (MSc) or an engineering Master's degree (MEng) in a relevant subject area from technology, agriculture or from a field, such as mathematics, physics, chemistry, computer science, biotechnology or earth science [2].

Rector regulations clearly define the schedule and stages of recruitment, especially dates for document submissions, qualification procedures, students admitted list and the decision of acceptance or non-acceptance [4]. Admission to PhD studies is determined by students' position in a ranking list (according to the planned number of students which is 15) established on the basis of the sum: average grade of study courses and points assigned on the basis of an interview on a scale from 2 to 5 (the interview evaluation is the arithmetic mean of faculty members of the Faculty Recruitment Commission at the Faculty of Environmental Engineering, CUT). The interview consists of two parts:

1. Issues related to the previous scientific and professional work:

    a) Thesis (thesis issues, theoretical or experimental way of research, the use of literature);
    b) Documented scientific achievements (e.g. participation in science clubs, conferences, seminars, internships, publications authorship or joint authorship);
    c) Research worker written opinion (certifying participation in scientific work).

2. Issues related to the future scientific work:

    a) Reasons for choosing PhD studies at the Faculty of Environmental Engineering, CUT;
    b) Issues of: water engineering, geotechnical, sanitary engineering, space heating, air conditioning, ventilation and the particular interests of a candidate [2].

## EDUCATION OF PHD STUDENTS

### The Establishment of Doctoral Studies

The author intends to describe the situation of the education of PhD students at the Faculty of Environmental Engineering at CUT in Kraków. This is based on the current status of the PhD curriculum made by the Faculty Board who has oversight of PhD studies. That means the Faculty Board applies to Rector with a request to establish PhD studies; requests to the CUT Senate on the conditions and procedures for recruitment and the planned number of students in the first year of PhD studies; expresses an opinion on the appointment or dismissal of the manager of PhD studies; enacts the programme of studies; and determines how to assess the PhD studies, including the research done by PhD students. The framework of studies and the recruitment procedure are defined in the regulations.

The selection of courses and the detailed scope of research and other responsibilities of PhD students are established by the manager of PhD studies on the recommendation of a supervisor. The manager of PhD studies is appointed by CUT Rector, after obtaining the positive opinion of the CUT Faculty Council and PhD Student Council. The manager of PhD studies may be an academic teacher holding at least a postdoctoral degree, employed full-time at CUT and performing work in the right department. The department, which conducts studies provides scientific supervision to PhD students for the entire period of studies and supports independent research. The supervisor may be an academic teacher or a researcher holding at least a postdoctoral degree in the field or a related discipline, and must have current scientific achievements published within the last five years [3].

### Studies Framework

PhD studies at CUT last no less than two years and no more than four years. However, the manager of PhD studies, at the request of a PhD student and after consultations with the student's supervisor, may extend the period of PhD studies (for no more than two years) in the case when long-term research carried out in the framework of these studies is needed. Also, it is possible to extend PhD studies in the case of temporary inability to conduct studies due to a student's illness, the need to provide personal care for a sick family member, etc.

The academic year of PhD studies in the scientific discipline of environmental engineering starts in the winter semester (1 October) and ends in the summer semester (30 September). Each semester consists of 15 weeks of classes,

the examination session (in a form of a written or oral examination or presentation of project results), the retake session and holidays [3].

To apply to obtain a PhD degree, the concerned person should initiate a PhD dissertation no later than before the end of the fifth semester of studies. Also, the student is required to have published the manuscript of a scientific publication in a book or at least one scientific publication (in a refereed scientific journal included in the list of scientific journals published by the Minister of Science) or in a refereed stream from an international conference or oral presentation of art work (e.g. poster).

A PhD degree is given to a person who has passed the examination in a modern foreign language or has acquired a certificate confirming the knowledge of a modern foreign language, presented and defended a PhD thesis and passed the PhD examinations. Examinations are carried out in the field of the basic discipline corresponding to the theme of the PhD dissertation, an additional discipline and a foreign modern language (in the case of not having a certificate). A PhD thesis, prepared under the direction of the supervisor, should be a genuine solution to a scientific problem and should demonstrate a general theoretical knowledge of the candidate and the ability to conduct scientific work independently [5].

The Curriculum

The curriculum includes a list of courses (compulsory and optional) with the intended year and the semester of their implementation, and the form of those courses (lectures, classes, laboratories, computer laboratories, projects, seminars), the way to complete the course, the number of hours and the number of ECTS points (points in the European system of accumulation and transfer of credits as a measure of the average amount of work) (Table 1).

The total points of courses and teaching practice covered by the curriculum corresponds to 30 to 45 ECTS. The student should collect at least 15 ECTS from optional courses. PhD students should consult with the supervisor on the selection of optional courses related to the methodology of their scientific research. Optional courses develop professional and teaching skills, which prepare PhD students to undertake research work and perform within the academic profession.

Each course corresponds to at least 5 ECTS. Total amount of hours is 740: in the first year 325 (1st semester - 155 hours, 2nd semester - 155 hours and 15 hours of teaching practice); in the second year 220 (1st semester - 125 hours, 2nd semester - 65 and 30 hours of teaching practice); in the third year 125 hours (1st semester - 45, 2nd semester - 50 and 30 hours of teaching practice): and in the fourth year, 70 hours (1st semester - 20, 2nd semester - 20 and 15 hours of teaching practice). Total ECTS is 45 points (41 - all courses and four in teaching practice) (Table 1 and Table 2).

Table 1: The curriculum of PhD studies at the Faculty of Environmental Engineering at CUT (selected and translated by the author) [6].

| Hours / Courses | 1 year | 2 year | 3 year | 4 year | ECTS |
|---|---|---|---|---|---|
| Obligatory | | | | | |
| Mathematics | 30 | | | | 2 |
| Fluid mechanics | 30 | | | | 2 |
| Thermodynamics | 30 | | | | 2 |
| Consultations with supervisor (2 semesters) | 10 | 10 | 15 | 20 | 3 |
| Continuum mechanics (for solids) | 30 | | | | 2 |
| Programming in scripting languages | 30 | | | | 2 |
| Statistical methods and theory of the measurements | 30 | | | | 2 |
| Optimisation methods | | 30 | | | 2 |
| Biochemistry and biotechnology | | 30 | | | 2 |
| Unit processes in environmental engineering | | 15 | | | 1 |
| Methodology of scientific research | | 15 | | | 1 |
| Management of research projects | | 15 | | | 1 |
| Institute seminar (2 semesters) | | | 20 | 20 | 4 |
| Optional | | | | | |
| English/German language (2 semesters) | 60 | | | | 2 |
| Different types of pedagogics/psychology (2 semesters) | 60 | | | | 4 |
| Philosophy/Ethics | | 15 | | | 1 |
| Course consultation with the supervisor (1 semester/2 semesters) | | 30 | 60 | | 6 |
| Institute seminar on methodology of teaching | | 30 | | | 2 |
| Total | 310 | 190 | 95 | 40 | 41 |

Also, PhD students are required to hold teaching practice in conducting a minimum of 15 hours or 30 hours classes (see Table 2).

Table 2: Schedule of teaching practice (translated by the author) [5].

| Year of study | Hours | ECTS points |
|---|---|---|
| 1 year | 15 | 1 |
| 2 year | 30 | 1 |
| 3 year | 30 | 1 |
| 4 year | 30 | 1 |
| Total | 105 | 4 |

Students are assessed on the basis of a six-grading scale (Table 3). The positive marks are: very good, more than good, good, pretty good, sufficient. The negative mark is: insufficient [3].

Table 3: Grading scale at CUT (translated by the author) [3].

| Verbal mark | Numerical mark | ECTS mark |
|---|---|---|
| Very good | 5 | A |
| More than good | 4.5 | B |
| Good | 4 | C |
| Pretty good | 3.5 | D |
| Sufficient | 3 | E |
| Insufficient | 2 | F |

Moreover, PhD students must participate in the work of the faculty organisational unit, which undertake independent PhD research (e.g. grants, conferences, scientific articles). At the end of the academic year all PhD students are obliged to submit a report of their scientific activities, protocol of positive examination grades and confirmation of teaching practice to the manager of PhD studies. The report should include information on the progress of independent and collaborative research, and the list of publications and published scientific articles confirmed by the supervisor. A PhD student who does not pass the course must repeat it during the next academic year. Participants pay a fixed fee for the courses they repeat. Those who default in their responsibilities may be removed from the PhD student list [3].

International Cooperation

Bilateral agreements have been signed by many research centres worldwide and participation in EU education programmes results in joint research, exchange of PhD students, as well as the ability to obtain additional certificates and diplomas. Collaboration with industry is also being developed. PhD students in the Faculty of Environmental Engineering at CUT in Kraków may apply for foreign trips based on e.g. Erasmus + programme or Erasmus practice.

This programme offers the opportunity to study at a foreign university in another country, make new scientific connections and gain a better knowledge of a foreign language. Erasmus + provides a unique opportunity to go to one of the countries participating in this programme for a period of three months, up to one academic year. The Erasmus + scholarship partially covers the costs of living abroad. The aim of Erasmus + is to raise the level of education to a higher level and to promote international cooperation between universities, especially through the expansion of the exchange of students and academics in Europe. Additionally, the Erasmus + allows PhD students to visit foreign institutions (e.g. business, scientific research institutions, non-profit organisations, design offices, etc) [2].

FINANCIAL SUPPORT AND SCHOLARSHIPS

All PhD students may apply for financial support, such as: a social scholarship, a special scholarship for the disabled, a scholarship for the best PhD student, the Minister's scholarship for outstanding achievements, an allowance and a student loan. PhD students may receive a scholarship if they passed their previous year of study. Financial support is granted for ten months in the academic year. The exception is for allowances, which are granted only once and a maximum twice in the academic year. Different types of scholarships and allowances may be combined (also the scholarship for the best PhD students together with the Minister's scholarship for outstanding achievements), when criteria for any of the benefits have been fulfilled.

A social scholarship may be given to a PhD student who is in a difficult financial situation, i.e. the income per person in a family does not exceed the threshold set at CUT. Special scholarships for disabled students may be awarded to a PhD student who has a disability confirmed by the decision of the competent authority. That scholarship is accorded regardless of family income. In the first year, scholarships for the best PhD student may be given to a PhD student who has achieved very good results in the recruitment procedures; in the second year and the following years the student needs to fulfil the following conditions: receive very good or good examination results under the programme of PhD studies, show progress in their scientific work and the preparation of the PhD dissertation, and be involved in teaching.

The Minister's scholarship for outstanding achievements may be awarded to a PhD student who has produced outstanding scientific or artistic achievements related to his/her studies or outstanding achievements in sport. An allowance may be obtained by PhD students who have found themselves temporarily in a difficult financial situation due to random reasons (death or serious illness of a family member, natural disasters) [2][3].

## CONCLUSIONS

The process of teaching PhD students at the Faculty of Environmental Engineering at CUT in Kraków, Poland, is based on an extensive curriculum of obligatory and optional courses. The learning approach to the PhD study consists of technical courses, teaching practice and participation in the work of the faculty organisational unit.

A significant part of the teaching programme is also international cooperation and industrial organisations in Europe that show that the experience and expertise of researchers from other foreign universities can be used in the educational process for mutual benefit. By realising its goals, CUT creates a widespread space for research and education giving PhD students the ability to self-educate and a strong basis for working in the modern market, arising with the development of civilisation.

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## BIOGRAPHY

Gabriela Zemelka is currently a PhD student at Cracow University of Technology in the Faculty of Environmental Engineering. She graduated with a Master of Environmental Protection from Jagiellonian University, and completed her postgraduate studies in analytical chemistry in industry and environmental protection at the AGH University of Science and Technology (Kraków, Poland), in 2013 and 2012, respectively. She has spent six months working in a laboratory and participating in a research project in the Department of Chemistry at Université Blaise Pascal in Clermont-Ferrand, France, before finishing her studies. As a young and aspiring scientist, she is interested in determination of the sources of suspended matter and sediments in water reservoir catchments, which will enhance the knowledge of the pollution of this environment. Her research has led to a description of the current contamination of reservoirs and may support analysis and predictions of water quality and sedimentation processes, and also the creation of tools to manage the catchment.