Teaching research-based gender competencies in STEM:
The study program GENDER PRO MINT at the Technische Universität Berlin

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INTRODUCTION

In this paper, the newly established and innovative study program GENDER PRO MINT[2] at the Center for Interdisciplinary Women's and Gender Studies (ZIFG) at the Technische Universität Berlin (TU Berlin) is presented.[3]

In the first section of this paper, the necessity of such a study program of Gender Studies as an integral part of engineering education will be evinced. Also, the target group, the current structure and the objectives of the study program GENDER PRO MINT will be described. The study program GENDER PRO MINT at the TU Berlin is a target specific study program to train students in gender competencies in science, technology, engineering and mathematics (STEM). These gender competencies include comprehensive and field-specific gender competencies as well as reflexive and creative gender competencies. Taught gender skills are based on knowledge of gender theories and focus on Gender Studies approaches in the STEM field in question as well as on Science & Technology Studies (STS). In particular, the ability to transfer these approaches to a study project or a qualifying thesis in a STEM field

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[2] "MINT" is the German acronym for "Mathematik, Informatik, Naturwissenschaften und Technik" (Mathematics, Computer Science, Natural Sciences and Technology) and as such the equivalent of the English acronym "STEM" for "Science, Technology, Engineering and Technology".
[3] The study program GENDER PRO MINT has been developed and established by Bärbel Mauss who coordinates the program since 2012. GENDER PRO MINT is offered at the ZIFG at the TU Berlin exclusively to students of STEM. A short description of the study program in German is given in [1]. Information on GENDER PRO MINT can be found on the website of the study program [2].

is being conveyed, aiming at the implementation of Gender Studies perspectives in science and engineering. In this way, gender competencies are related to both research results of Gender Studies and current research and development in science and engineering.

In the second section of this paper, it will be exemplified how students are being advised while they carry out their study projects as part of the study program GENDER PRO MINT in the project modules. The process of carrying out a study project is divided into three overlapping phases: Firstly, an in-depth understanding of the assigned task needs to be acquired concerning its concepts, theories, methodology and prospected results. Secondly, Gender Studies competencies that have been acquired during former courses of the study program GENDER PRO MINT allow students to analyse how the assigned task at hand is 'gendered' with regard to its concepts, prospected results, applications and uses. Thirdly, perspectives of intersectional Gender Studies in science and technology are to be integrated into the project. Students learn how to develop analyses of 'gender' in STEM through re-shaping and possibly transforming the initial task assigned to them in a STEM field. Therefore, study projects of students of the study program GENDER PRO MINT show how possible transformations of both Gender Studies and research of STEM fields as possible outcomes. The study projects serve as examples of how the objectives of the study program GENDER PRO MINT are to be reached. In these study projects, perspectives of Gender Studies have been integrated into the contents and approaches of students' study projects in STEM fields.

1 GENDER STUDIES IN STEM: GENDER PRO MINT (B. MAUSS)

1.1 Why a study program on Gender Studies for students in STEM?

Today, students of STEM need competence profiles that not only include professional knowledge but also relations of this knowledge to gender and diversity in particular, since they are the ones who will plan our physical, technical and infrastructural environment, and thus their knowledge will have significant impacts on our lives. Therefore, they need to acquire the ability to identify and to solve problems by including social and life-world contexts in order to develop constructive, gender-equitable solutions. Thus, 'the bigger picture' becomes a decisive factor in science and engineering science education.

During the last years, more and more institutions from politics to education have called for taking into account gender and diversity aspects: Also universities aim to offer opportunities for gaining gender competencies to their STEM students. So far however, this is mainly done in the form of additional offers such as lecture series or individual training modules for teachers. In most cases, these offers have little or nothing to do with the contents of the STEM study subjects. With the study program GENDER PRO MINT we take another road, since we link the issues in STEM disciplines with issues of gender and diversity through tasks that have been assigned to students in STEM. Students ask for knowledge about gender and diversity but so far, they usually do not get such offers due to inadequate conditions - for example the usually non-existent integration of Gender Studies in the compulsory area of engineering study courses. The profiles of the study programs in STEM should be extended in order to train future technology designers and scientific researchers to consider and to integrate gender and diversity issues in research, in planning processes and in technology design. For reaching this goal, Gender Studies should be taught in STEM disciplines. However, there is still a lack of skilled teachers in the STEM disciplines who have acquired the necessary knowledge to teach topics and

methods for gender analysis. Meanwhile, many German universities offer courses and training for students on gender and diversity issues. But these courses mostly focus on the education of women with regard to developing their soft skills and career planning. The objectives of these courses are not related to the contents of science and technology or to issues of technology design and scientific research. GENDER PRO MINT closes this gap because its courses are part of the profile range of the courses in the study programs in STEM.

The experiences of the first three years with the study program GENDER PRO MINT have shown that the STEM students' interest in such topics is very large under these conditions. These first years have also indicated that we do not only need to develop specific teaching and learning approaches but also specialised teaching materials on gender and diversity issues. This is a prerequisite of allowing a diversity of STEM students to participate in such a study program that combines knowledge of Gender Studies with their particular STEM study topics in relation to the contents of science and engineering. Taking the students' interests into account, only a close integration into a general Gender Studies degree program allows conveying Gender Studies expertise as professional competence for such a study program in a sustainable way. The study program GENDER PRO MINT therefore addresses the question of how gender and diversity knowledge can be made productive for engineering education and for the subsequent professional practice. It is not taught in addition to study courses of STEM but Gender Studies knowledge is taught in integrative ways in relation to the contents and approaches of STEM.

1.2 Target Group, Teachers and Structure of GENDER PRO MINT

The study program GENDER PRO MINT at the TU Berlin started in March 2012 with the introductory course "What have natural and technical sciences to do with gender?" - developed and taught since then by Bärbel Mauss. The program can be completed with a "GENDER PRO MINT Certificate I" (18 ECTS) and the consecutive "GENDER PRO MINT Certificate II" (12 ECTS) of the TU Berlin. GENDER PRO MINT is offered exclusively to the *target group* of bachelor, master and PhD students of the STEM at the TU Berlin. Currently, more than 200 students have registered for the study program; more than 110 students have successfully completed at least one module of GENDER PRO MINT. In November 2014, the first GENDER PRO MINT Certificates of the TU Berlin have been awarded to the first graduates at TU Berlin.

Who are the *teachers* and where is the program located? - GENDER PRO MINT is located at the *Center for Interdisciplinary Women's and Gender Studies (ZIFG*), a renowned research institute with a focus on STS directed by Prof. Sabine Hark. The students may attend all courses of the ZIFG within the program as well as a variety of Gender Studies courses at other universities in the Berlin area. We supervise study projects in cooperation with the faculty in STEM.

At the moment, the structure of the study program is shaped in accordance with study courses of STEM fields at the TU Berlin. The study program consists of five consecutive modules (30 credits in total) [2]:

1) *Introductory Module* (4/6 ECTS): The overarching question of the introductory module is: "What is the connection between science and engineering sciences on the one hand and gender on the other hand?" In this module students learn the fundamentals of Gender Studies in STEM fields starting from scientific and technical concepts, practices, designs and professional images.
2) *Advanced Module I* (9 ECTS) - Profile development in Gender Studies: In this module students get deeper insights into different topics of Gender Studies.

3) *Project Module* (6 ECTS): The overarching question of this module is: "How can we translate the knowledge of Gender Studies in STEM into a concrete study of their own field?" In this module students reflect on the professional culture as well as on the content and practices of their own field through carrying out study projects in science or engineering science.
4) *Advanced Module II* (4 ECTS) - Profile development in Gender Studies: The students get a deeper insight into the relevant fields for the final project.
5) *Final Project Module* (8 ECTS) - Gender and Diversity in the design of research projects and technology: The students transfer gender skills into technology and research design.
Graduates receive the "GENDER PRO MINT Certificate I" of the TU Berlin (18 ECTS) after having completed the third module and the "GENDER PRO MINT Certificate II" of the TU Berlin (12 ECTS) after having completed the fifth module.

1.3 Gender Competence and the Objectives of GENDER PRO MINT

What are the *objectives* of the study program? - With GENDER PRO MINT we offer a target group specific study program to train students in research-based *gender competence* in science, technology, engineering and mathematics: Research-based *gender competence* in STEM in the study program GENDER PRO MINT is based on current research in Gender Studies. Therefore, gender competence cannot be taught as fixed knowledge. Rather, research-based gender competence must be understood to be in process. Students in STEM at the TU Berlin are trained in research-based gender competence in the structured study program GENDER PRO MINT at the following levels of competence:[4]

1) *Reconstructive gender competence*. Objective: Students acquire knowledge about key terms, concepts of Gender Studies and knowledge of important fields. They learn how Gender Studies in STEM are systematised in order to be able to reconstruct scientific studies in Gender Studies to STEM.
2) *Field-specific gender competence*. Objective: Students develop the skills to transfer methods as well as gendered and epistemological foundations of the scientific studies to their own area of expertise in STEM.
3) *Reflexive-creative gender competence*. Objective: Students in STEM develop the skills to reflect systematically on their own or internal positions and unquestioned assumptions, settings etc. in STEM. Students learn to transfer knowledge and skills about 'gender' and STEM to new situations through theoretical and methodological approaches.
4) *Shaping gender competence*. Objective: Students learn to develop and shape new projects and new questions and new approaches in their own field in STEM based on their acquired expertise in Gender Studies.

What are the *learning outcomes*?[5] - Firstly, students learn to point out issues and questions from a gender perspective, for example: "Who are the users?", "What are the effects of technology?", "What are unspoken pre-conditions in science and engineering?" Secondly, students learn to analyse social, cultural-historical and epistemological backgrounds of science and engineering as well as to analyse concepts and practices in science and engineering from a gender perspective. Finally, students are able to implement the acquired gender skills into technology and design, into research and teaching and - overall - into their own professional expertise.

[4] The concept of 'research-based gender competence' in GENDER PRO MINT is described in [2] and [3].
[5] The learning outcomes of GENDER PRO MINT are described in more elaborated ways in [1] and [2].

2. INQUIRY-BASED STUDY PROJECTS ON 'GENDER' IN STEM (P. LUCHT)

For the implementation of 'gender' perspectives into engineering education, it is suggested to follow an inquiry-based approach of learning and teaching of intersectional Gender Studies in STEM fields. This approach has been developed by the guest professor at the ZIFG, Petra Lucht, in 2013 and 2014. Petra Lucht advised study projects of students in GENDER PRO MINT in the above-mentioned project modules.[6] In these project modules, students learn how to consider and integrate gender and diversity aspects into their study projects as well as into their qualifying theses (BA, MA and doctoral level). The students' study projects show that it is possible to identify, to consider and to integrate - in various ways and to various degrees - perspectives of intersectional Gender Studies within a relatively short time span of one semester into research, development and planning in STEM fields.

Three phases of working on a study project in GENDER PRO MINT over the course of a project module have been identified: In phase 1, a study project in STEM has to be chosen and described by the student, during phase 2, a range of analytical dimensions and of taxonomies of intersectional Gender Studies in STEM are discussed with respect to the study project. In phase 3, particular approaches of Gender Studies in STEM are selected, specified and implemented into the study project.

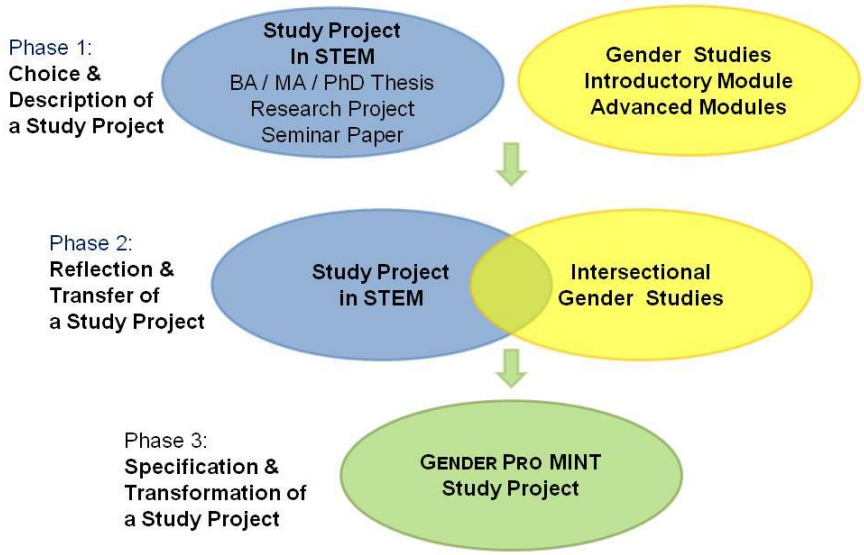

Fig. 1. Phases of working on a study project in GENDER PRO MINT at the TU Berlin

2.1 Phase 1: Implementing the integrated »Hourglass Model«

During phase 1, the suggested approach is inquiry-based in the sense that gender and diversity aspects cannot be added to a given research design or process as an 'extra' and pre-shaped element. Rather, a research design or process model for carrying out research and/or development needs to be reflected with regard to implicit and explicit gendered assumptions that may be inscribed into goals, concepts, research questions, methodology and results of a project. This reflection is promoted further in the presented approach of teaching through the »Hourglass Model« following Maxwell (1996) [4]. This integrated model is suggested to firstly

[6] Petra Lucht is holding the Guest Professorship on "Gender Studies in Engineering" at the ZIFG at the TU Berlin since April 2013. In particular, she is responsible for advising students in STEM on to carry out their study projects in the two project modules of the study program GENDER PRO MINT.

enhance reflections on the interrelatedness of genderings of the elements of a research design or process model. Secondly, reflections on the results of research or the envisioned products of a development process may show implicit and given notions of 'gender'.

Fig. 2. Photo (private)
adapted from Lucht (2014) [5]

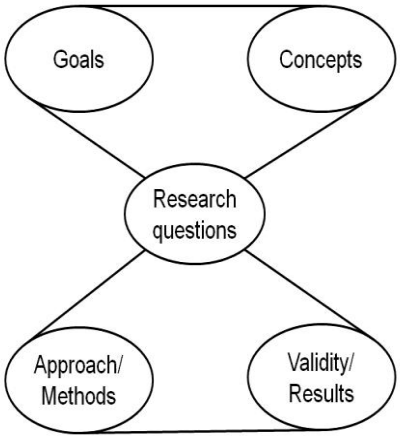

Fig. 3. The »Hourglass Model«
adapted from Maxwell (1996) [4]

2.2 Phase 2: Reflections of intersectional Gender Studies

During phase 2 of working on a study project, students recapitulate a range of approaches of Gender Studies that they got to know in the preceding introductory and the advanced modules of Gender Pro MINT. So far, the following three perspectives serve as exemplary texts for discussions on - intersectional - Gender Studies in STEM:[7] the threefold taxonomy on Gender and Science suggested by Evelyn Fox Keller (1995) [6], the four analytical dimensions for analysing the gendering of artefacts by Corinna Bath (2008) [7], and finally the intersectional perspective in Gender Studies by Katharina Walgenbach (2007) [8][8]. Through discussions within the group over the course of a project module, one or more analytical perspectives of intersectional Gender Studies are chosen in order to identify specified approaches for the project as well as to work out in-depth reflections and transformations of a study project.

2.3 Phase 3: Implementation of intersectional Gender Studies

In this subsection, we hint at three examples of study projects that have been worked on in project modules of the study program GENDER PRO MINT in 2013 and 2014.[9]

Medical Engineering - Mareike Okrafka, a student of medical engineering, worked on intersectional Gender Studies perspectives in GENDER PRO MINT for both of her study projects [9]: her first study project aimed at developing a dynamic seat for a

[7] A more elaborated discussion of these readings is given in [5]. These approaches are not complete or mandatory, but are discussed to promote students' systematic understanding on 'gender' in STEM.
[8] In fact, Katharina Walgenbach criticised the dominant concept of intersectionality: She suggests to conceptualise 'gender' as an interdependent category [8]. This is discussed in detail in [5].
[9] These and further study projects were presented to the public by students of GENDER PRO MINT on July 5th 2013 (Computer science: Melanie Irrgang, Medical engineering: Mareike Okrafka, Urban and regional planning: Toni Karge, and Climate research: Franziska Kaiser and Max Metzger) [9] and on May 14th 2014 (Computer science: Melanie Irrgang, Landscape architecture: Anne Miersch and Regina Otters) [10].

wheel chair for children that have cerebral palsy; her ongoing second study project aims at extending her master thesis in medical engineering on the further development of a device to enhance "Tele-Rehabilitation in case of a stroke". For reflecting on how gender and diversity aspects have been inscribed into these technologies, Mareike Okrafka discussed in her study project the concepts and norms of autonomy and self-determination as they have been formulated in Disability Studies and Gender Studies. In both study projects, 'gender' is created at intersections of the so-called 'social' context with 'artefacts' - in this case medical devices for physical therapy in case of permanent or temporal disability.

Landscape Architecture: - Playgrounds in the 1950s and after 2000 **-** In her master thesis in landscape architecture Anne Miersch compared exemplary children's playgrounds in the city of Berlin of the 1950s with contemporary playgrounds while she focused on possible genderings of these urban spaces [10]. She asked: "What do playgrounds tell us about our society?" Also, she investigated how 'gender' is defined on the administrative level and in open space planning. Anne Miersch concluded that contemporary gender-just planning is based on the shortened assumption that 'gender' was a dualistic category. At the end of her master thesis, Anne Miersch presents her own design of a playground that is inspired by queer-feminist theories.[10] This study project locates 'gender' at intersections with concepts of 'space' and with 'entities' that are classified in relation to these 'spaces'.

Computer science: Violent scene detection with Semantic Search - Melanie Irrgang, a student in computer science, pursued the question "Might gendered concepts also be reproduced in semantic search in computer science?" for her study project on "Violent Scenes Detection in Semantic Search - A Gendered Evaluation" [9] [11]. She reflected on a task assigned to her in computer science: to survey a range of contributions to a competition event for detecting violent scenes in Hollywood movies with the help of semantic search. Melanie Irrgang analysed how gendered assumptions about violence were inscribed into the developed software. This study project highlighted the intersections of 'gender' with 'artefacts' that are currently developed in computer science.

Last but not least, a note on intersectional Gender Studies: These and further study projects highlight that intersectional Gender Studies should not be restricted to 'social' categories of inequality. Rather, the concept of intersectionality in Gender Studies should be broadened especially in the context of Gender Studies in STEM. The documented study projects might serve as first signs on these roads: In these projects, 'gender' is re-created at intersections with 'space' - in this case in landscape architecture - as well as at intersections with 'artefacts' and 'devices' - in these cases in technology development in computer science and medical engineering.

SUMMARY: RESEARCH-BASED GENDER COMPETENCIES IN STEM

In this paper, the newly established and innovative study program GENDER PRO MINT at the ZIFG at the TU Berlin, Germany, has been presented. This study program is structured and conceptualised in ways that allow students to acquire research-based gender competencies as an integral part of their engineering education at the TU Berlin. One of the main teaching concepts of the study program is that students integrate gender and diversity aspects into given study projects in STEM. Through working on these study projects, students learn how to implement gender and diversity aspects into STEM. One of the objectives of the study program GENDER PRO

[10] With this design, Anne Miersch has won the first price of the student competition "Gendersensible Campusgestaltung. 2.0" (Gender-sensitive design of the campus) at the TU Berlin in 2013/14.

MINT at the TU Berlin is to train students in the ability to analyse science and technology from multiple Gender Studies perspectives. Learning outcomes enable students to consider and to integrate gender and diversity needs while developing scientific knowledge, developing planning processes and developing technology.

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