

## ***Engineera* - a programme for female students of electrical engineering and information technology**

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**ABSTRACT:** In 2007, a female student tutorial called *Engineera* was established at the Technische Universität München, Germany, in the Department of Electrical Engineering and Information Technology (EI). This programme addresses the needs of female electrical engineering and information technology students. The motivation, goals and methods of the tutorial are explained in this article. A typical semester programme is outlined and the pros and cons of a mono-educative approach in a co-educative field of study are discussed. The results of the evaluation of the tutorial are outlined and discussed and, finally, future work and conclusions are also presented.

**Keywords:** Female students, network, orientation aid, drop-out

### INTRODUCTION

*Engineera* was established in 2007 and is a tutorial for female electrical engineering and information technology students at the Technische Universität München. This includes all semesters from the first to the last and can be attended on a voluntary basis and does not require any registration. The semester programme contains excursions, practical projects, information events and discussion groups. All in all, there are about six events during a semester.

Two female student tutors (one a Master's student of electrical engineering and information technology, the other a Master's student of educational theory) and a research assistant organise and maintain the tutorial. With this combination, the scientific background for the practical projects, as well as the educational background for didactic preparation of the events, is given.

To finance the programme, every semester a payment out of the tuition fees is requested and has to be granted. The goal of the tutorial is to offer female students a vast network with other students and female engineers and to keep them in a field of study that is male dominated. (In Germany, there are 20.9 % female students in this engineering field [1]).

### MOTIVATION AND GOAL OF THE PROGRAMME

Especially in engineering study paths, the drop-out rate in the early semesters is high [2]. As in all subjects, the decision for aborting one's engineering studies cannot be explained mono-causally; however, in engineering, there is often a particular central reason [3]. Most frequently mentioned in this context are problems in performance and a lack of motivation to study [4-6]. To support the students in the first semester of their studies, the *Engineera* tutorial was established, together with other offers from the EI department.

In electrical engineering and information technology, the percentage of female students in the first semester at the Technische Universität München has never reached 12 per cent. In the first semester, students often feel lost in the *new* concept of the university. They have to find their place and orientate themselves. It is especially difficult for female students, as many of them are not sure if they have selected the right direction. The main goal of the *Engineera* programme is to keep at least those few female students in the field of study by providing orientation aid. This is achieved by several means.

Excursions to a range of companies give the students an insight into their possible future job and contacts for internships or theses. Also, practical projects with the students are set up during the tutorial. In these practical and problem-based projects they learn how to use their theoretical background [7]. This leads to a loss of fear of contact and gives them more self-confidence in front of the male students. In discussion groups and other events, female engineers are present and tell about their lives and career. In addition, alumnae of the tutorial and also of the Technische Universität München take part in these events.

This is of special interest for the students as they have an exclusive insight in to being an engineer and can ask them about anything. It is important even for female students to have role models and examples on, e.g. the compatibility of a family and career [8]. *Engineera* is also a platform to create a network with other students, as well as companies or female engineers. Especially for students in the early semesters, it is important to have contact persons from later semesters to help them with questions or concerns. For the students, it is in their interest to create a network and, perhaps, utilise it as company contact for internships or even a job.

## DISCUSSION ON A MONO-EDUCATIVE APPROACH IN A CO-EDUCATIVE FIELD OF STUDY

The technical and engineering field is stereotypically masculine connoted [9]. The experiences of women who start their studies in engineering sciences and the stereotypical role models they encounter can be discouraging. Effects of gender stereotypes not only come up at the threshold of access to a particular field of study. They also relate to women who have opted for an *atypical* study path and must cope with it [10]. Male domains function exclusively, typifying competence attributions seem daunting [11]. The *Engineera* tutorial will help to ensure that female electrical engineering and information technology students are promoted from the very beginning of their studies. Among other goals, it is intended to reduce the dropout rate in this study path. The female students receive a *single-gender island* in a co-educational environment.

The objective of equal opportunities for both genders has not been implemented through the co-education, at least not at the expected level. Recent research findings raise doubts if co-education - at least in the form of actual realisation - is at all adequate to ensure effective equality of opportunity in education (e.g. University of Essex, 2009 [12], Illinois State University, 2006 [13]). Many results indicate that a co-educational environment applies a greater pressure for the students to adapt the traditional gender roles. To counter this, either the *reflexive co-education* or a temporary separation of the genders is propagated. The latter in particular in subjects, in which gender differences in performance or interest is stated [14]. By having a temporary single-gender education in a co-educational environment for study, the students develop their skills, interests and knowledge without having the pressure to perform [15].

School research shows that it is beneficial for girls and boys to be involved in temporary single-gender experiences [16-20]. A temporary separation may increase among other things, the self-concept of students and have a positive impact on the subject-specific motivation [21][22]. This approach is transferred to the University in the *Engineera* tutorial. An evaluation of the course by use of a standardised questionnaire is undertaken every semester. These results are shown below.

## METHODS OF THE STUDENT TUTORIAL

The method of the tutorial is peer-educational from students for students. Two students, supported by a research assistant from the Department of Gender Studies in Science and Engineering organise and carry out the events. The research assistant helps the tutors in methodical and organisational questions. One student is from the field of electrical engineering and the other from the field of pedagogy. This interdisciplinarity has proved to be the ideal combination of technical and methodical background [23].

The whole programme is offered on a voluntary basis and the students can decide which event is of interest to them. No registration is needed, but the students sign on to an e-mail list so that they can be informed about upcoming meetings. Other ways of communication are via Facebook, the department homepage, posters and a presentation at the first meeting. Registration can be necessary for excursions or events with a restriction on the number of participants, because of visitor identification, limited material, limited seating or other reasons.

The rough procedure for one semester is as follows: a meeting takes place about every two weeks, in the evenings after class, except for the excursions. The first meeting is always introductory, at which the *Engineera* tutorial is described and the participants learn to know each other. Then, the procedure differs each semester depending mostly on the dates that the companies provide for visits. For about the last two years, there have been two excursions each semester, one of them to a city other than Munich for a whole day and the other for a half-day excursion near Munich, so that the students do not miss out on many classes.

The companies are chosen through contacts with the Department of Gender Studies in Science and Engineering, family members or friends of the students who work in a company of interest, student requests (evaluation) and Internet research. Most companies are glad to introduce their work and organise a programme for the female students. This can

include, e.g. a tour through the assembly lines or other interesting parts of the company, a workshop with female engineers, lunch and a presentation about career entry in the firm.



Figure 1: Excursion to National Instruments GmbH.



Figure 2: Excursion to Infineon Technologies AG.

Most of the time, the practical project in the winter semester is a soldering project. The tutors conduct some Internet research about a small project or ask engineering research assistants for ideas. Then, a prototype is manufactured by the tutors to see if the project works and how much time it takes. For the soldering project, two or a maximum of three dates were scheduled. The circuit plan and basics of soldering are explained via a presentation and a hand-out. Of course, help is offered for the students at work if problems occur. Some examples of those practical projects are: LCD with control board, solar cell operated LED, binary dice. In the summer semester, a programming project is offered. Therefore, four LEGO® MINDSTORMS® RXT robots are used. Every year the students, in groups of two, have to solve a range of programming tasks with the robots, and the winner is decided in a small competition at the end of two meetings. The robots are built in the first meeting and the task is presented. In the second meeting, the writing and implementation of the program is done. The programming language is a C-based language, called *Not-Quite-C*, which the students can easily apply as they learn C-language in class. A short overview over the program and the tasks are also introduced in a presentation. Tasks include writing something with the robot, following a black line or detecting impacts.



Figure 3: Soldering project.



Figure 4: Programming project with LEGO® robots.



Figure 5: Discussion group with an engineer.



Figure 6: Networking.

Discussion groups, information evenings and networking events take place for three or four hours in the evening. For discussion groups, two or three female engineers from different companies (e.g. from those who *Engineera* visited) are invited. First, they introduce themselves and talk about their occupational development and, then, they volunteer to answer students' questions. The students get to know the engineers and their network is extended yet again. Even personal contacts get exchanged for organising internships or thesis at their company. At information evenings, students research into the topic, and tutors provide a short hand-out with important information. If possible, electrical engineering alumnae and information technology are invited. Then, similar to the discussion groups, a networking evening takes place. Topics for the information evening are; for example, sponsorships during studies, semesters or internships abroad, career and family.

As briefly described in the procedure of the *Engineera* meetings, the didactic methods of introducing the topic of the event is done by presentations and hand-outs. However, it is desirable for the students to work independently. That means that in practical projects, methods are presented but the students should do the work alone or with colleagues. Help is given by the tutors if needed. Very little input is given at discussion group evenings, so the students can really ask about what they are interested in. This helps to improve the independence and self-confidence of the female students.

## RESULTS OF THE EVALUATION OF THE TUTORIAL

At the end of every semester, an evaluation is sent to the students via e-mail to evaluate and justify the work *Engineera* does. The evaluation is a standardised, anonymous and voluntary questionnaire. The items evaluate all the areas dealt with in the tutorial (excursions, practical projects, networking and so on). This makes it possible to see exactly what the strengths and challenges of the tutorial are. To grade the questions, a five-point Likert scale (1 = very bad to 5 = very good) was used [24]. The following graphs show the average values of the topic selection, practical project, excursions, contacts and orientation in the first semester from winter semesters 2009/2010 and 2010/2011 and summer semester 2010 and 2011.

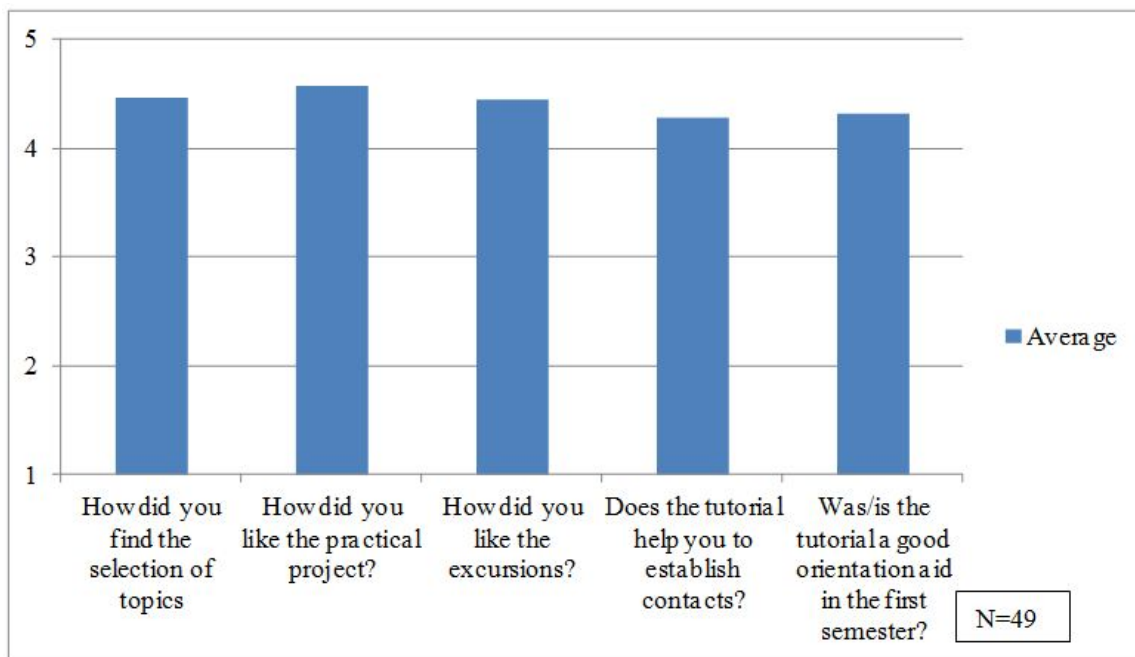


Figure 7: Results of the evaluation (1 = very bad, 5 = very good).

The students reviewed the tutorial as being very good. The selection of topics discussed during the semester was rated well (4.47). In particular, the overlapping of course content and topics of the tutorial was positively evaluated. In addition, the students assessed very positively that they can try out theoretical knowledge in practise. The course participants gave this topic the top mark (4.57). The wishes and preferences of students were considered during the planning of excursions to various companies in the Munich area. The results of the questioning show this effect by a very good rating (4.45). Furthermore, the students reflected positively on the opportunity to socialise and to make contacts with more experienced students in the tutorial (4.28). Also, the tutorial was seen as being an excellent orientation guide for the participants during the first semesters (4.31).

The results of the evaluations show that the responses are *very good to good*. Improvements can still be made but it is obvious that the programme is helpful and interesting for the students. Those illustrations are chosen generically to visualise the results. The evaluation of the other questions is similar to the graphics shown. It is easy to see that *Engineera* obtains continuously good results throughout the semesters.

The tutors evaluate the questions that require a written answer and these are taken into account for subsequent semesters' activities or other improvements.

## CONCLUSION AND FUTURE WORK

All in all, the tutorial receives a very positive evaluation and is co-created by the female students. The motivation for the field of study of electrical engineering and information technology is increased and help and orientation aid is accepted, especially in the early semesters. Some of the students wrote in the evaluation: *I am very happy that there is an organisation like Engineera where one can find support and receive the benefit of many useful and interesting projects. And it is always fun with you! I liked to get the opportunity to talk to higher semesters. One could talk about their upcoming tests and get rid of the fear. I am very happy that there is such an organisation in our field of study because one feels a lot more taken care of.* Those statements show the importance of the existence of *Engineera* and give a great feedback for the tutors.

For the coming semesters, the basic procedure is being retained as it has proven to be very good. Small adjustments can still be made after further evaluations in the coming semesters. In the current semester, the practical project is the programming project with the LEGO®-robots. The task is to build a pen holder with a third motor and to program the robot in a way that it can write the word *LED*. The excursions are to a company in the field of robots on special request of two students and to the Deutsches Museum in Munich. Also, an information evening is planned with the topic of sponsorships during the studies and semesters or internships abroad.

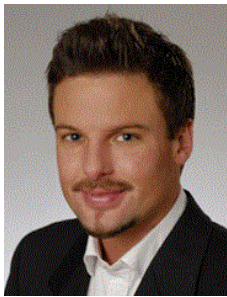
As long as the tuition fees are obligatory and the tutorial gets the approval of the Technische Universität München, the tutorial will go on to help female students at the Faculty of Electrical Engineering and Information Technology integrating themselves into a male dominant environment.

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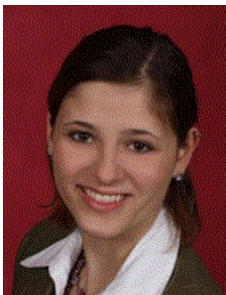
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## BIOGRAPHIES



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