

Getting in Touch with Experts – Problem Based Learning in the Engineering Education

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ABSTRACT

In 2007 a new symposium was introduced at Technische Universität München as part of the gender program of the excellence initiative – the Liesel Beckmann-Symposium. The participants of this event were students of electrical engineering as well as participants from universities and companies. They learned about gender and diversity in product and personnel development in lectures and workshops. Via methods of Problem Based Learning they were sensitized about the topics and learned by role plays how to implement gender and diversity in their own work. Afterwards the symposium was evaluated. Results show that students learn a lot through this kind of engineering education and are highly interested in the topics gender and diversity.

Keywords

Gender and Diversity, Problem Based Learning, Diversity in Product Development, Diversity in Personnel Development

INTRODUCTION

The approach of Problem Based Learning has been introduced into higher education and engineering education during the past years. The main goal of this approach is to teach students how to learn and to change the curriculum towards more student centred learning. It is important for students to learn skills that are necessary in the “real world” of the engineering profession. These skills are “problem analysis and problem solving, project management and leadership, analytical skills and critical thinking, dissemination and communication, interdisciplinary competencies, intercultural communication, innovation and creativity, and social abilities”[7].

To implement the topics of gender and diversity into engineering education it is useful to introduce different kinds of teaching and learning. With the foundation of the Liesel Beckmann-Symposium, not only a symposium but also a new learning environment for students was born. From 2007 on this symposium will be held regularly once a year. It is organised by the IAS – Institute for Advanced Study at Technische Universität München. The topic is

gender and diversity in different fields of research and science. In 2007 the topic was “Gender and Diversity in the Technical Culture”.

THE SYMPOSIUM

The topic of Liesel Beckmann-Symposium in 2007 was “Gender and Diversity in the Technical Culture”. It was chosen as important for all TUM faculties and with target groups from different research areas. The symposium was designed with one day of scientific inputs through lectures and a second day with workshops where participants could experience working with gender and diversity in small groups. These workshops included elements of Problem Based Learning as an approach to change learning methods for students towards more process oriented work. In between and in the end there was enough space for discussions and networking and the reflection about the new insights. The lectures on the first day dealt with gender and diversity in research, product development and personnel development. The workshops on the second day deepened these topics and let the participants experience them¹.

For the Liesel Beckmann-Symposium 2007, TUM could win three experts working in different fields of gender and diversity. First of all this was Londa Schiebinger, Professor at Stanford University, USA, who has been researching on feminism and gender in the technical culture for a long time. She presented how research changes if the male bias is recognized and changed into an equal participation of male and female researchers and fields of research. Her examples come from history, ethnology, health, natural sciences, and research institutions (comp. [9], [10]).

The second lecture was given by Martina Schraudner, Visiting Professor at Technical University Berlin and representative of Fraunhofer Gesellschaft, a non-university research institution which is application oriented. Schraudner has developed a programme called “Discover Gender”, dealing with product development in the focus of gender [3].

The first day was completed by Ursula Schwarzenbart, director of the Global Diversity Office at Daimler AG in Germany. She is responsible for the implementation of diversity aspects at Daimler AG. On the second day, at the end of the symposium was the last chance to get into contact with the experts in a so-called “world café”, where the experts invited interested participants to a “coffee party” on topics they were interested in.

¹ To get some impressions of the symposium and the full programme, please visit: <http://www.tum-ias.de/current-focus-groups/gender-diversity/2007-gender-technology.html> (29.1.2009).

One important aspect of the Liesel Beckmann-Symposium is the broad target group. It is supposed to reach university-members from different faculties as well as scientists and researchers from outside the university. The participants are junior and senior researchers, students from different faculties and representatives and experts from companies. This field forms an interesting group for discussions and workshops. In this year's symposium students from electrical engineering and information technology were integrated into the symposium via a link to the lecture course "non-technical requirements in the engineering profession" held by the authors.

In the following we will first deal with the topic of the symposium and show why it is important for engineering education. Later we present how the students came into contact with the topic of gender and diversity via methods of Problem Based Learning (PBL). The concept of PBL deals with the idea, that knowledge will be learned more easily and more deeply, if it is applied to a complex question and worked out in teams.

GENDER AND DIVERSITY IN THE ENGINEERING CULTURE

Up to now the professional image of engineers is male dominated and institutions of engineering education are still places of a male majority. Universities have not yet thought about their influence on the amount of female engineers in society. But stirred by the recent discussion in Germany about the demographic change and the lack of specialists, the topic "women in engineering" has reappeared on the agenda as it has regularly since the 1990s [8], [4], [2], [1]. Companies are introducing diversity offices and try to care for the different needs of their diverse workforce. The concept of Diversity Management means that the diversity of people is treated with respect and highly valued.

Gender and diversity are topics that are relatively new in the engineering field. There are two ways both topics come in. The first way is the technical development, the question of products, developed under a gender and diversity focus. It is more and more important to develop products that fit better for the needs of customers.

The second way to include Diversity Management is the personnel development. Companies searching for engineers today have to care for different groups of people, like older employees, female employees or minorities from other cultural backgrounds. Diversity Management includes gender as one dimension of diversity. In Europe the gender dimension is often seen as most important in Diversity Management as in the technical field gender equality is far from being reached.

Of course the two lines meet each other! The idea behind gender and diversity strategies is to support a diverse workforce, which will hopefully lead to the product developments having a diverse customer group in mind. This means that these topics have to be integrated into engineering education. Ihnen and Buschmeyer [5] have

shown that these topics can be seen as key competencies in engineering education today.

German companies as well as universities are searching for male and female engineers due to a lack of highly qualified employees. TUM and its engineering study programs are searching for possibilities to make technical subjects more attractive to (young) women [11], [6]. Female engineers and engineering students often have to excuse for deciding for "unusual" subjects and need better results to prove their competence [12]. As the engineering profession is changing into a modern profession where not only research and development are possible occupational profiles but also marketing, sales, customer service and target group orientated innovations, it is necessary to prepare engineers for different directions. This means that engineering education has to become closer to engineering everyday-problems and needs more elements of social skill training including sensitization for gender and diversity topics. It is what companies expect today from universities as the educators of their future employees.

The Liesel Beckmann-Symposium is seen as a chance to implement these important topics and skills into the engineering education program of TUM.

TEACHING STUDENTS ON GENDER AND DIVERSITY THROUGH PROBLEM BASED LEARNING

Research has shown that engineering students, especially female and "non-typical male" students, wish to find more interdisciplinary research and Problem Based Learning to improve the engineering study program [12]. One possibility to do so was the idea of integrating the Liesel Beckmann-Symposium into the lecture course "non-technical requirements in the engineering profession" as part of the study program of electrical engineering and information technology, and open the symposium to students from mechanical and civil engineering.

The idea of integrating students into an expert's conference was new. It was based on the idea that they should understand the topic of gender and diversity through other forms of teaching than lecture course or (student only) seminar (comp. [5]). By getting to know experts from industrial and university research and personnel development in a technical company the students realised that the topic of gender and diversity is part of their future profession. With these insights the students were able to understand the problem of integrating gender and diversity into technical working processes from a more practical point of view, without the usual prejudices that mostly engineering students (and teachers) have towards these topics.

As mentioned above, crucial elements of the symposium were the workshops. The participants of the workshop were asked to work in groups, dealing with topics of the engineering profession, to take over group presentations and leadership and to develop problem solving strategies. It is most important that the students understand the problem and are curious to find a solution by critical thinking and self-directed learning strategies (comp. [7]). In between and

in the end there was enough space for discussions and networking and the reflection about the new insights. To teach students in this way, a problem has to be provided to the students. The topics of product development and the problem of integrating the needs of the customers are appropriate for this kind of learning. As soon as they understand that this might be a problem they are able to handle it. Therefore, it is important to sensitize the students towards gender and diversity by changing their roles and widening their point of view. The specific methods will be presented in the following.

A workshop on gender- and diversity-inclusive product development

In the workshops, students had the possibility to learn about the topic of product development. The problem that was presented to them in an introductory presentation was that many products have been developed that had never found a market because customers did not buy them. The reasons for this could be that the development has never been market oriented and that the future customers weren't been integrated in the development process.

The method of this workshop was a role play, to make students realize the different needs of diverse user groups. The participants were first asked to develop a role they knew, but that was not their own. With this task they had to think about needs and requirements they would not have thought of in their "own role". Representing the chosen role they were divided into two groups and were asked about the needs they have from their new perspective towards a future car (group one) or a future technical household (group two). For the students it was very exciting to see how different and even contradictory their wishes were: One was representing an old lady who said that her house should be safe from technical failure and should tell her family if she had an accident. A student representing a young boy said he wanted the house to be full of technical equipment, but that his parents should not be able to realize what he is doing in his room. Most people wanted easy-to-use-and-clean equipment. In the other group a student representing a mother claimed that she wanted a save car with a sound system entertaining the children but not the driver.

All these examples show that gender and diversity aspects were visible within this workshop; the roles differed in age, gender and professions. They had different needs when they were parents or seniors. The students realized that they could not only develop products for their own needs – a task they had never thought of before. The takeover of another role made it possible to experience these needs and thus students understood the theory better than they would have when only hearing about it.

A workshop on gender and diversity-inclusive personnel development

The main focus of this workshop included gender and diversity related issues in the organizational context. The problem that was mentioned to the participants was how to

implement gender and diversity as a strategy in the organisational structure and culture.

In special exercises the participants explored different aspects of diversity. In a first step attendants should be able to realize what diversity in a company means. A role play, similar to this in the other workshop, was introduced. The goal was to obtain gender and diversity awareness, which means the ability to recognize and identify gender related aspects of facts and situations. The attendants found out a lot about the difference and commonality between each other.

Participants had to find solutions to this problem as a group. In these two practical parts of the workshop, students were asked to act and design concepts. After that they learned about the specific measures of organizations e.g. mentoring for women, quotes for personnel recruiting and gender sensitization trainings for managers. This input-based part of the workshop was interesting for the students because they realized a connection to what they had experienced before. Theoretical and practical experiences were combined to sustainable knowledge.

By working on this topic students and other participants were able to realize the importance of diversity for their future career.

EVALUATION BY PARTICIPATING STUDENTS

One important aspect of PBL is to ask the students what they have learned during the learning process. Ten days after the symposium the participating students were asked to fill in a questionnaire about their experiences with the concept and the contents of the symposium. All of the students gave a very positive feedback and they all thought that the way of learning in the symposium is very interesting and should be part of their curriculum because it is relevant to their profession. For the evaluation we asked the students both: what is the content they take home and how did they experience the symposium. About 15 engineering students took part in both days of the symposium and attended the workshops on the second day (more than 30 participated attended the symposium in one or the other day).

On average the results were very good or good. The best grades were given to the workshops indicating that this – for many students new – kind of learning was interesting to them. The comments the students were asked to give on the symposium are very interesting as well. They all expected insights into the topic of gender and diversity. The answers in the feedback-sheet made clear that many of the students had not thought about the topic before and that they thought it might not be useful for them. For most of them it became clear during the symposium that the gender and diversity topic touches male and female life.

Another question was "What did you like most of the symposium?". Many students claimed they liked the atmosphere of learning, the open discussions and the willingness of men and women to discuss this topic together. This shows that the chosen method was right,

students liked the way of learning, they learned a lot and took home new insights. All but two of the students say that they would like to take part in more events like this as part of their study program.

Furthermore, we asked the students in an open question what message they take home from these two days. All but one of the students took home new ideas and impressions.

The comments can be clustered into:

- Students got information and knowledge about gender and diversity
- Students realized that the topic of gender and diversity is important for their future working life
- Students think that gender and diversity has to be included into product development processes
- Students can imagine that positive action makes sense to build mixed teams

CONCLUSION – INFLUENCE ON HIGHER EDUCATION

A symposium like this shows that different kinds of education lead to better effects than the presentation of topics in lecture courses does. The evaluation shows that students like this kind of education. Students were asked to take part in an event that they thought would not be interesting for them. Afterwards the majority of them would have liked to take part in more events like this. In the written exam two months later it was obvious that those students who took part in the symposium could answer questions about gender and diversity in technology more problem oriented and not only by heart. Some of the answers described processes of the workshops.

Students were hardly interested in the topic before and thought about it quite negatively. But by interesting presentations, lectures and workshops they were able to find access to the important topic of gender and diversity in engineering. The approach of PBL, the active participations and the role plays, lead to better comprehension and a sustainable knowledge about topics important to their future career, because students remember the elements better when they experienced them by themselves. The design of the symposium and the workshops support learning effects through interaction of theory and practice.

The aim of Gender Studies in Science and Engineering is the combination of active teaching and learning in order to know what gender, diversity and equality mean.

To teach students of engineering on gender and diversity is part of the curriculum in electrical engineering at Technische Universität München. By teaching them what this is and what it means for their (professional) lives sensitizes them towards more responsibility. To do so the professorship Gender Studies in Science and Engineering has developed courses based on action theory and problem based learning in which students deal with gender and diversity in combination with other topics. In different seminars like “presentation and communication for engineers” or “successful teamwork” gender and diversity are two topics next to others, which make it much simpler

to talk about the issues with the mainly male student-group. In other seminars and lectures on “interdisciplinary aspects of the engineering profession” students learn about gender and diversity as part of their future professional skills.

Furthermore, we have developed a course program dealing with gender and diversity in organizational development. In this interdisciplinary course, students from different subjects like business administration, electrical engineering and consumer science come together to learn about something they have not dealt with so far in their study program. Their task in this course is to teach each others about several topics of organizational development from a gender perspective. While teaching (and therefore thinking not only about the topic but also about appropriate teaching methods) students start to think about target group orientation, about their own professional life and how to use the new knowledge for their work. During the first course in summer 2008 we learned how the view towards the topic changes from rather negative attitude towards the insight that these issues might touch the participants as well.

With a role play students realize the different needs of diverse user groups. The participants first are advised to develop a role that they know, but it is not their own one. With this task they are able to think about needs and requirements they would not have thought of in their “own role”. The takeover of another role makes it possible to experience these needs and thus students understand the theory better than they would have, when only hearing about it.

It is important to discover with the students, if they had chosen the same role like their fellows, the development would not have been the same. This is an important conclusion since they have to understand the differences between target group orientation, diversity and stereotypes. For the future the participating students are supposed to see gender and diversity aspects in their own research activities as important questions that have to be dealt with when they develop products as engineers. They were sensitized to mention gender and diversity aspects in their future research and development by attending the symposium which told them that this problem has to be solved in all of their future work.

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