

# Conferencia Internacional de Ingeniería Mecánica “COMEC 2019”

## Empowering girls and women to enter STEM<sup>1</sup> fields of study and careers, and stay the course

**Manuela Kanneberg<sup>1</sup>, Heike Mrech<sup>2</sup>**

manuela.kanneberg@ovgu.de<sup>1</sup>

heike.mrech@hs-merseburg.de<sup>2</sup>

Otto-von-Guericke-University Magdeburg, Magdeburg, Germany<sup>1</sup>

Merseburg University of Applied Sciences, Merseburg, Germany<sup>2</sup>

Dipl.-Ing.<sup>1</sup>; Prof. Dr.-Ing.<sup>2</sup>

### **Abstract:**

Even in a high-tech country like Germany the proportion of female students in the so-called STEM subjects is considered too low. Therefore colleges and universities face up to their social responsibility and make important contributions to the recruitment and care of female students. At the Otto-von-Guericke-University Magdeburg and the University of Applied Sciences Merseburg in recent years, many new forms of events - for girls and boys - have been promoted and gained experience. The article explains selected pilot projects and gives recommendations for the reuse of especially successful event forms. These ideas bear in mind different, already identified deficits and try to set new incentives for the target group but even foster new ways of thinking about career orientation and life planning.

These include multi-day workshops called "Science Camps," Women's Power Days, Field Trips, Technology Camps, Social Networking, meeting Role Models and Mentors.

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<sup>1</sup> Science, Technology, Engineering and Mathematics (STEM) is a term used to group together these academic disciplines.

As digital literacy and technical knowledge are vital for women to be responsible for shaping the future within an information- and knowledge-based society one important task is to deliver gender-responsive STEM education, including teacher training, educational contents and pedagogy. To this end, our University develops and carries out a wide range of initiatives and projects that exploit the potential of women as well as men to make equal opportunity a reality in all spheres of society and work.

**Keywords:**

STEM Education; Careers; Educational Robotics; Digital Integration; Gender Gap; Women

**1. Introduction**

**1.1 Less women than men in STEM**

Substantial differences in the social participation of women and men in STEM careers are statistically proven. Despite significant advances in recent years, girls and young women continue to be underrepresented in STEM degrees and careers.

According to Statistik Bundesagentur für Arbeit [7] women comprise 46% of the German workforce. The proportion of women employed in STEM occupations is rising slowly, but with 15 percent it is still quite low. The proportion of women who started a dual STEM vocational training was only 11 percent in 2017. The number of STEM students (women and men together) is higher than ever. The interest in STEM subjects has also increased among women. However, the proportion of women remains low at 28 percent. There are clear differences between the different disciplines. The highest proportion of women is in the field of mathematics and science with almost 40 percent of female employees. In technical and computer science occupations, however, the proportion of women is only 13.8 and 16.1 percent. As a result, women are missing opportunities to participate in the nation’s most highly paid and fastest growing occupations.

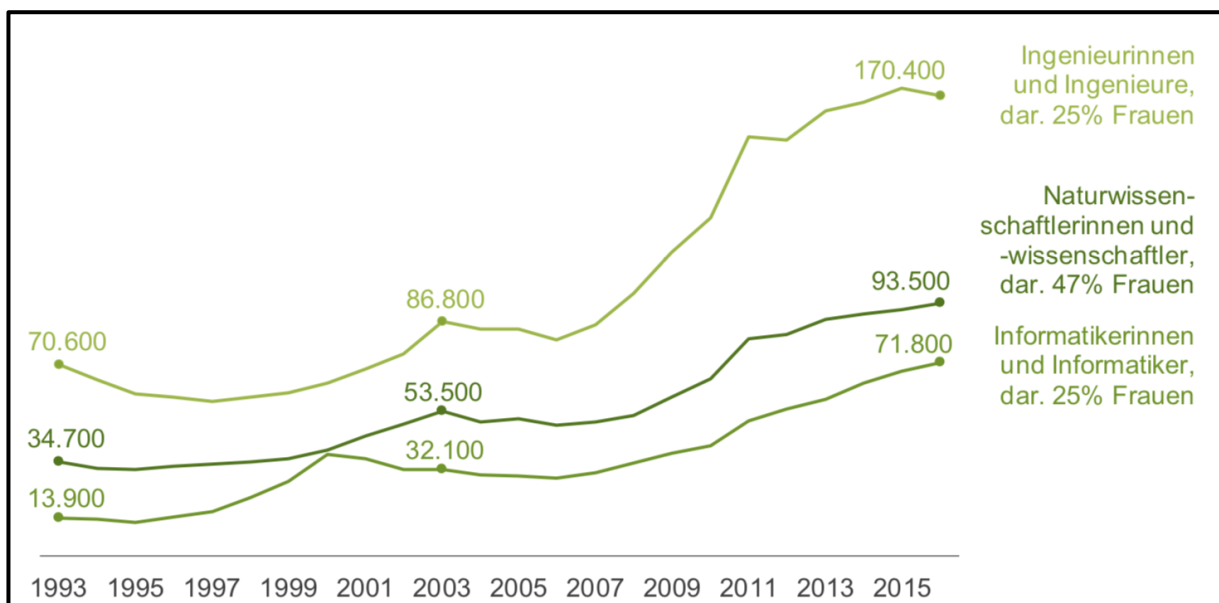


Figure 1: Number of STEM undergraduate students is growing [7]  
 Students \* in the 1st semester in selected fields of study or subjects, percentage of women

Various reasons contribute to the upswing in STEM subjects: Good prospects for the future, as well as challenging tasks, made visible to the prospective students in many informative campaigns, have increased the interest in studying STEM. In addition to this special effect, there is a general trend towards higher qualification. Therefore, the number of eligible students has risen by a good 14 percentage points to 45 percent in 2016 over the past ten years. There has also been a noticeable increase in the interest of foreign students in STEM studies in Germany.

There are a number of reasons why girls and women do not join the STEM career system, including lack of early education and insufficient course preparation in school. In particular a lack of parental support and a lack of role models and mentors highly influence the situation of young women in STEM. In addition, stereotypes about “appropriate” roles for women still play a large part in lowering girls’ aspiration for science and engineering careers. Out-of-School Time (OST) programs (afterschool, weekend, during summer vacation) offer unique opportunities to address these issues and help to increase girls’ interest and participation in STEM. Research has shown that effective OST programs can promote girls’ achievement in STEM through fostering engagement and self-identity and creating a greater confidence in science ability [5] They increase STEM knowledge and skills, further persistence in the STEM pipeline, increase interest in and improve attitudes toward STEM careers, change course-taking behavior at school, and change perceptions of who can do science. In addition, funded programs provide an opportunity to reach low-income and minority children.

Below is addressed the role that extracurricular events and learning places can play in facilitating girl`s success both in personal and professional ways. One project that illustrates the agenda - the “ZUKUNFT FEMININ” project, funded by the Ministry of Justice and Equality of Saxony-Anhalt and the Operational Program of the ESF - is described.

## **2. Methodology**

ZUKUNFT FEMININ - Women discover mathematics, computer science, natural sciences and engineering: is a funded project<sup>2</sup>; The aim was to inspire young women from grade 9 onwards with specific, mutually supportive offers for mathematics, computer science, science and technology, to support them in finding talent, career and study choices and to promote their opportunities in the training and employment market.

Primarily, the project objectives of “ZUKUNFT FEMININ” are:

- Promotion of technical and scientific interest in girls and young women
- Suggestion and offers to try themselves out in the fields of mathematics, computer science, technology, engineering and natural sciences
- Assistance in choosing a profession / course of study and starting a career
- Support in finding the own talents and strengthening self-confidence

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<sup>2</sup> ZUKUNFT FEMININ - Women discover mathematics, computer science, natural sciences and engineering, September 2015 to December 2018, funded by the Ministry of Justice and Equality of Saxony-Anhalt and the Operational Program of the ESF.

## FEMININ – METHOD

### Phase 1 – FEMININ informs

- Communication with students (directly and through educational multipliers on career and education fairs and via social media)
- Information about and sensitise students for STEM-subjects
- Develop interests and discover talents

### Phase 2 – FEMININ supports and strengthens talents

- Individual support for the participants
- Developing self-esteem for STEM
- Girls/Women find and strengthen their own interests and talents, they try themselves out new things in FEMININ events and internships

### Phase 3 – FEMININ forms the future

- Advancement of existing STEM interests
- Consultations for career options and choices
- Getting to know role models and new perspectives



Figure 2: Impressions “ZUKUNFT FEMININ”

## FEMININ – Results

- Website with register function, events and news
- Social media appearance on Facebook
- Special Advertisement material (Merchandise)
- Newsletter for interested girls and women
- Developed event plans and schedules

- 254 participants at FEMININ-events (“Schnuppertage“, "Science Camps"; “Women's Power Days”, Field Trips, Technology Camps, internships)
- ca. 1.500 reached young women through information events (fairs, school visits etc.)

The following specific offers and formats have been implemented:

**FEMININ-on tour:**

Project Days at school,  
extend the focus to the rural regions of Saxony-Anhalt,  
informing and activating participants on STEM topics and professions and project offers

**FEMININ informs:**

Exhibition and action stands on educational fairs / in schools

**FEMININ links up digital:**

FEMININ digital groups und FEMININ webinars,  
Involvement of regional companies in the offerings for placements and networking of role-models, disclosure of company information, etc. on training and career opportunities.

**FEMININ very close to the job:**

Providing educational and event formats that allow participants gaining STEM experiences, to recognize talents and to develop STEM self-esteem,  
advancement of STEM interests and talents as well as support in the career choice decision  
Strengthening the STEM career decision by networking with female STEM models (apprentices, female students, Female researchers, company employees ...),  
clearing up doubts, developing STEM skills and developing insights into STEM practice through multi-day events such as science camps and internships,

**FEMININ released:**

Website; Social Media, public relations, networking, Teaching / learning Movies

### 3. Results and discussion

Obviously, there is a difference between men and women with perspective on choosing an occupation in the STEM field, but clearly it is not a biological one. Cultural and social norms influence girls’ perceptions about their abilities, role in society and career and life aspirations. Decisions about what fields of study or employment are considered possible or appropriate for men and women are deeply embedded in the socialization process. Mass media play an important role in the socialisation process, influencing opinions, interests and behaviours. Gender stereotypes portrayed in the media are internalised by children and adults and affect the way they see themselves and others.

Girls need support to develop positive math and science identities, belief in their abilities and a sense of belonging in STEM studies and careers. Even brief interactions have been found to shape the student beliefs about their potential for success in STEM. [8]

**Different self-perception and self-awareness** – Girls and young women tend to underrate their own talents and abilities

**Different goals and interests** – Girls and young women show in their interest for STEM certainly other qualitative focuses like environment or aid/support

**Influenced differently by surroundings** – Stereotypes / different social status/backgrounds and diverse standards of values and norms

At each science camp, a film documentary was produced together with the participants, which is well suited to convince other girls but also parents and peers of the abilities of the participants. In addition, small videos with job profiles were created.



Figure 3: Screenshot from the video „From Talent to Dream Job” – ZUKUNFT FEMININ

- There is a steady need for study and job-oriented events for female students to face their diverse insecurities and endless questions
- Increasing motivation for a STEM job is best achieved by getting to know job-related activities, discovering one's own talents and sharing ideas with role models
- Based on their good performance in school female students need to discover their potential and opportunities and improve their self-concept and self-confidence. In OST – events pupils were able to unfold, try out and make new contacts with like-minded without external pressure
- In the case of informed female students, there is an increasing demand for internships for vocational and study orientation.

Projects like ZUKUNFT FEMININ can create worlds:

- in which it is normal to prove yourself as a STEM woman.
- where women exchange and empower each other among women of equal talents.
- where women discover new opportunities and find promising, attractive career paths.

The main activities of a planned follow-up project are:

- STEM project days with practical units (for example: small programming exercises, series of experiments or the construction of mini-robots) at schools in the rural districts of Saxony-Anhalt
- present suitable occupational profiles and professional opportunities of the companies based in the region e.g. as small video clips
- subsequent digital exchange in the form of digital groups / collaboration with Sharepoint, Skype workshops and webinars
- Excursions / Science Camps to get to know specific job opportunities even better and to get in direct contact with role models such as apprentices, female students, researchers and other corporate actors

The results clearly confirm what works for girls: collaborative learning with an emphasis on practical applications and teaching of science in a more holistic and social context along with the combining of hands-on activities, role models, mentoring, internships, and career exploration. The experiential, hands-on nature of the learning provides experiences that help girls make a personal connection to science and to convince family and peers as well. Last but not least, the close ties between project staff and young people are an essential part of our programs and make this environment particularly conducive to learning experiences.

#### **4. Conclusion**

The Otto-von-Guericke-University Magdeburg and the University of Applied Sciences Merseburg have developed and tested a large number of successful STEM interest promotion offers in recent years. This motivates children and adolescents to become more involved in STEM topics, to discover and develop their talents, and to use them for successful STEM careers. They have very good experience and competencies in study and vocational orientation along the educational chain from elementary school to graduation and entry into studies or vocational training. The project successfully collaborates with numerous high schools, vocational schools and technical secondary schools, the employment agency, institutes of further education and companies in central Germany.

Based on this cooperation in the area of Magdeburg and around Merseburg; in addition to “ZUKUNFT FEMININ”, other projects are being implemented to promote study and vocational orientation in the scientific and engineering sciences. (e.g. at the Otto-von-Guericke-University Magdeburg: “RoboCupJunior”, "ego.-tech-on" and "ego-MINT"; "Ing-Web" and at the University of Applied Sciences Merseburg: “student laboratory- Chemistry to touch”, "Merseburger Technik-Club für Schülerinnen"; "BEANING"...) )

To increase the efficiency and breadth of their projects a successful cooperation was established between University of Applied Sciences Merseburg with the project partner Otto-von-Guericke University of Magdeburg. The cooperation partners intend to bundle their varied experiences and competencies from a large number of individual projects, resulting in an expanded, integrated, regional offer with consideration of the rural area and the future topic of digitization.



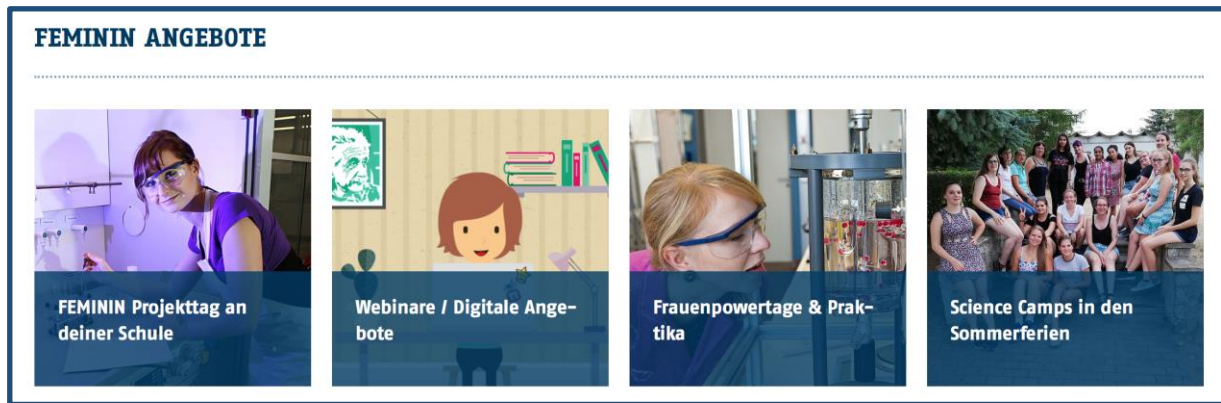


Figure 4: Project`s FEMININ offers in the subjects of mathematics, computer science, natural sciences and technology to participate, experience and try out

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