Dealing with diversity in engineering education:
Qualifying teaching staff for working with diverse student groups

Abstract

Context

At Technische Universität (TU) Berlin/Germany, among 32,000 students almost 20,000 are enrolled in engineering subjects. Depending on the subject, one third or less are women. 19% (about 6,100 students from 130 states) are among the highest number of international students within German universities. Speaking of multidimensional diversity, teaching staff faces mostly incomparable formal entry qualifications, low practical competences, distinct preconditions and learning styles. TU Berlin has a long tradition of study reform and initiated a new teaching and learning (TAL) culture in 2010. This means designing, implementing, reflecting, and evaluating active innovative TAL environments. How do we improve teaching staff´s competences to maintain high quality teaching, cope with gender, diverse international students, non-traditional learners and promote cultural change? How should TAL projects in technical subjects be designed to foster diversity competences for teachers and students?

Concept

Change development to establish a new TAL culture happens on two levels:
1. by implementing more active learning processes to promote study success,
2. by qualifying teaching staff, in particular specially trained teaching change agents (TCAs), for innovative methods and diversity in active learning environments.
Active student-centered, project- or problem-oriented methods support learning processes and enhance quality and success rates by acquisition of generic competences. However, this concept compared with traditional formats may not benefit all learners. The qualification of engineering students and TCAs is in the center of our project "tu wimi[plus]": besides improving teaching competences, TCAs develop innovative teaching curricula within teaching projects in their own subject-specific teaching for diverse student groups. They are also responsible for disseminating good teaching practices to colleagues.

Competences

Gender and intercultural competences are particularly relevant for student qualification. Which competences are desirable to work with diverse student groups? Teaching staff and TCAs are trained in the existing accredited program for TAL and tailor-made offers. Our diversity training (gender, intercultural aspects and learning styles) must be developed.

Contribution

The paper illustrates the TCAs-concept as feasible, sustainable support structure to qualify teaching staff for diverse student groups, provides solutions how to integrate diversity aspects into project- and problem-oriented learning and explains the steps and conditions for implementing this approach.

Conclusion

Diversity and gender relevant innovation and best practice need to be dealt with by teaching staff in higher education as they have relevance for students around the globe. Our response for teachers in engineering education is the concept of a diversity sensitive pedagogical education for teaching staff in higher education and in addition the new approach of recruiting and qualifying TCAs as disseminators for good practice approaches. Recommendations for teacher's and TCA's competence development for gender, learner and intercultural diversity

concern workshops focusing on didactic and professional knowledge as well as on improvement of pedagogical skills and individual attitudes.

Full Paper
1. Context
At TU Berlin, among 32,000 students almost 20,000 are enrolled in engineering subjects. With 19 percent (more than 6,100 students coming from 130 states) this is among the highest number of international students compared to other German universities. Depending on the subject, only one third or much less than the average are women studying in engineering studies. Speaking of multidimensional diversity with regard to international students, teaching staff faces almost incomparable formal entry qualifications to higher education, low practical competences, distinct preconditions and learning styles. It may be the qualification level Bachelor or Master, but admission is also given to different equivalent, practically oriented technical education biographies. Our university has a long tradition in education and training reforms and efforts to improve the quality of teaching and learning. In 2010, a sustainable change in our teaching and learning culture has been initiated. In this context, innovation means designing, implementing, reflecting and evaluating active, project- and problem-oriented teaching and learning methods.

The current situation raises the following questions: How do we improve the teachers´ competences to maintain high quality teaching and to cope with gender, learner and intercultural diverse student groups? How should innovative teaching and learning projects in technical subjects be designed to foster diversity competences for both teachers and students? What kind of qualification do TCAs need to encourage active learning and arrange appropriate environments and to promote a cultural change in teaching and learning?

The crucial question to generate responses to global challenges in engineering education in our context is: how can we recognize and address the essential diversity of all humans actively involved in teaching and learning? This includes gender, intercultural and learner's diversity in general as well as teacher's competence development in engineering education.

Some actions to implement the approach are developed in the paper and mentioned in the final chapter:
- a commitment of higher education institutions to enhance quality and retention rates of engineering education by taking diversity into account,
- to foster active learning, goal-oriented recruiting and qualification of teaching staff for these aspects by sensitizing them and integrating relevant new topics into the curricula,
- diverse country specific and international approaches and variations of curricular and tailor-made offers as well as
- sustainable financial support for the continuous and focused pedagogical qualification of teaching staff.

The word "diversity" is a buzzword originating from the American respectively the Anglosaxon language. Literally translated to German it also means "diversity, variety, heterogeneity, plurality, and divergence". The meaning of diversity is differently defined in educational contexts and different sciences and difficult to precise according to its multiperspectivity and intentional openness[1].

Some short international references can highlight today's agenda: The respective American approach in engineering education focuses on women and minorities[2]. Target groups of managing diversity in classrooms consist of non-traditional students that means discriminated minorities according to gender or ethnic affiliation. This has also been a long-time focus of concerned teachers and teacher educators[3].

In Europe, the change of methodology for studying introduced by the Bologna-Reform, reflected in the so-called "Shift from Teaching to Learning", also takes diversity into consideration. A European academic network (38 institutions in 27 countries, founded 2012) aims at defining quality criteria that characterize teaching and learning in this new so-called "Multilingual and Multicultural Learning Space"[4].

The following table indicates the different elements of the "Multilingual and Multicultural Learning Space" (MMLS):

Dimensions (actor)	Focus of activity (process)	Quality principles (conditions)
1. The institution	Educational context & institutional environment	1.Providing an inclusive learning space 1.1 Providing institutional support for learning-conducive environments 1.2 Integrating students and staff in the institution
2. The teacher	Educational processes	2.Raising awareness about teaching and learning processes 2.1 Reflecting on teaching approaches and negotiating learning processes 2.2 Managing and leveraging diversity
3. The student	Educational outcomes	3.Developing one's own cultural identity and extending one's knowledge base 3.1 Benefitting from awareness of cultural differences and the ability to deal with linguistic diversity 3.2 Acquiring and applying contextual and intercultural knowledge to different cultural contexts

Table 1: Different elements of the multilingual and multicultural learning space[5]

The following model shows the approach of the network project:
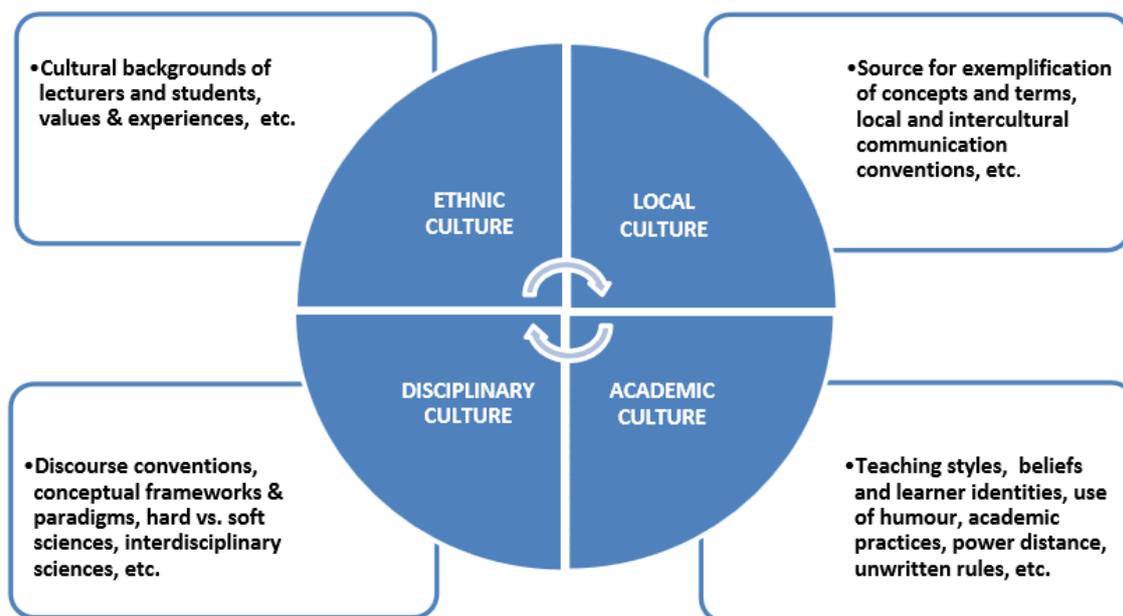
Graph 1: Model for culture in the internationalization of higher education[6]

The overall goal is an inclusive, learning-conducive environment where all operative, administrative, managing, and teaching working levels are involved and cooperate. For our purpose tu wimi[plus] this is a suitable map to develop diversity courses and diversity management activities for the qualification of TCAs. This perspective on the level of the institution, the teachers and the students will be reviewed in the subsequent sections.

In Germany, a change of culture is seen as a basic presumption for a university-wide appreciative interaction with diversity in studies and teaching. General strategies allow only few generalizable quotes concerning the success of concepts and measures, and there is no unique success model or panacea: "The more diversified the biographies of university members are, the more diverse is the range in the exchange of ideas, perspectives and experiences – and the wider is the creative potential to accept new global challenges."[7]. Dealing with diversity is a cross-functional task that has to be integrated into organizational development. Pro arguments are the success orientation of universities and the outlook to future working processes. A general demand lies in the necessity of a teaching and learning culture with an approach to student-centered teaching and competence-orientation for all students.
The German diversity competence network[8] offers a continuing education program for professionalization in diversity management for all staff in studies, teaching administration and management of higher education institutes.

An important element to master a diversity teaching and learning culture is the didactic and pedagogic continuing education of the teaching staff. The diversity competence has to be developed by qualifying all staff and by focusing on executive managers as they have to operate diversity measures in their teams and select new staff in application procedures.

Teacher education has to deal adequately with the diversity of pupils and students. Teaching staff need to arrange their classroom and teaching activities to different learning types. Of significant value are measures that consider diversity during the transition from school to university and during the early study phase. To improve the graduate rate is target of continued study support. Barrier-free information techniques can ease the situation of handicapped students when communicating with teaching staff and examining boards[9]. For successful implementation, an active support of diversity management by university and executive management is essential and has to be taken into consideration in internal and external communication. Also, organizational structures for diversity management demand provision of resources and clarification of responsibility.

The implementation of reformed conditions and characteristics in teaching happens in faculties and central support structures. It aims at the enhancement of the process quality in each lecture or classroom as well as the cooperation and communication structures of all people involved[10]. Aspects of diversity of teaching staff can be located in their professional culture, gender, physical condition, origin and age[11]. Therefore, a multidimensional personality is characteristic[12].

In Germany, the award for excellent teaching in higher education will be devoted in 2016 to the topic "diversity-compatible teaching and learning"[13].
Until 2015, 70 German universities and universities of applied sciences have signed the "Charter of Diversity". TU Berlin joined this charter in April 2013[14].
At the moment, 35 German universities and universities of applied sciences undergo the procedure of a "Diversity Audit" by the "Association for the Promotion of Science and Humanities in Germany". For TU Berlin, this could be a topic in the future[15].

Our university mission how to deal with diversity demands is described as follows: "Our university members are actively engaged in promoting equal opportunity between women and men and in creating family-friendly study and working conditions. We strive to ensure equal opportunity and non-discrimination at all levels of the university organization. In our teaching and research we also explicitly embrace the plurality of world views and diverse ways of life."[16].
Consequently, TU Berlin offers various courses addressing gender and diversity themes. One example is a study module which aims at qualifying engineering students in diversity questions and solutions for the future workspace[17].
In the university reform process "campaign knowledge by learning" (2005-2008) important selection criteria for the application for study reform projects were, among others, aspects of gender and internationalization as well as appropriate further education. One of the results was a publication with examples of best practices for implementing gender topics in a variety of teaching projects in STEM-subjects[18].

"As diversity management has a growing strategic meaning for the governing processes of universities, … 8 corresponding project lines have been developed. In each line diversity is more or less directly addressed, therefore they build another step towards implementation of our general orientation"[19].

Funded by the Federal Ministry of Education and Research in the national university funding program "Hochschulpakt 3 (HSP3)", the project line tu wimi[plus] is supposed to contribute to an increase of female students in STEM-subjects by generating a higher attractivity of the introductory semester phase[20]. Furthermore the project application indicates the following

strategic goals: "With the project line tu wimi[plus], it is intended to improve the staff number with a special focus on over-employed teaching areas in STEM-subjects. This means to promote approaches that support project-oriented learning (tu projects), e-learning based teaching and learning methods (tu digit) and the implementation of gender aspects into teaching for all Bachelor students."[21].

Core of project line tu wimi[plus] are qualifying measures by continuing education and consultation programs for the scientific staff of TU Berlin. The intensive didactic training for teaching in higher education is supplemented by additional "education months" and the development of special continuing education concepts and herewith allows a competent approach to the diversity theme. … The recent discussion shows that "dealing with diversity" is already one of the requested future themes for teaching in higher education."[22].

2. Concept

In this context, the development of a new teaching and learning culture happens on two levels of action:

1. by implementing courses with more active learning processes to facilitate and promote greater study success in diverse student groups,

2. by qualifying academic teaching staff for innovative methods and diversity in active learning environments: regular staff and specially recruited TCAs.

The qualification of engineering students and TCAs (as disseminators) are key aspects of our project tu wimi[plus]: besides the improvement of their teaching competences, TCAs' key task is to develop innovative curricula within the frame of teaching projects for diverse student groups, which they apply directly in their own subject-specific teaching. Additionally, they are responsible for the dissemination of good teaching practices to their colleagues. For the future this means that gender and intercultural competences become topical within the qualification of students.

In general, it is assumed that active, participatory social learning methods, such as student-centered, project- or problem-based approaches, support learning processes and foster students´ study success by acquiring generic competences or soft skills. Our understanding of educational innovativeness comprises also context-oriented, interdisciplinary or exemplary learning. However, this may cause specific problems as this innovative learning concept compared with more traditional formats may not benefit all learners equally. Therefore special forms of multiple learning environments are helpful.

The benefit of active learning has been proven by different American investigations that indicate the improved learning results compared to lectures: active learning increases student performance in science, engineering, and mathematics[23]. The question whether learner diversity leads to better learning results has been answered by several American investigations with the observation that diverse groups can be positive for the development of innovation and creative problem solving[24]. It indicates four typical learning styles that can be combined in different profiles in reality[25]:

- "practical": preferably learning in projects and with examples,
- "analytical": systematic presentation of contents in lectures, independent learning with learning material,
- "communicative": interactive learning in groups or projects,
- "authoritarian": needs clear guidelines for goal-oriented learning.

Even when different learning style theories may be criticized, they are useful as reflective instrument for teaching[26].

Why do we need diversity sensitive education? Dealing with diversity and understanding diverse identities as normal, implies a corresponding thinking ability. The challenge is to respond to student diversity by increasing the diversity of suitable teaching and learning arrangements[27]. The teaching staff must be qualified to identify the dimensions of diversity in their classes and to adjust their pedagogical approaches accordingly to improve knowledge, skills and competence achievement and to raise success rates.

2.1 Diversity of students in teaching and learning environments

Gender
In 1993, a study focusing on female students in engineering subjects has sensitized for discriminating mechanisms in teaching and learning interaction between teaching staff and among students and in the choice of subjects and tasks in teaching and learning materials. Female students then demanded: "I don't want to be promoted, I just don't want to be hindered."[28]. This study and the following discussion started a meanwhile long tradition at (University) to keep an eye on corresponding mechanisms.
The general student statistics today[29] show an average of 33% female enrollment among students with a higher percentage in human sciences and a lower percentage in engineering and natural sciences.
The lecture-oriented mathematics lessons generate a rather static understanding of maths and in this way discriminated female students with a more dynamic process-oriented perspective[30].
In physics, the gender theme can be addressed via contents, e.g. by indicating the professional contributions of female physicists. The teaching approach is context- and activity-oriented and aims at holistic learning, combined with experiments, using all-day-material, learning with phenomena and peer-instruction, cross-linked and self-determined, and with formative tests and exams[31].
As an example, in our teaching project in mathematic tutorials, students calculate themselves in average 70% and further 30% of all calculations are demonstrated by student teachers. Student tutors as beginners have to undergo a didactic training. More exercising is possible now and also supervised by a didactically trained teaching assistant, who is giving additional lectures.

International students
Statistics of TU Berlin show that approximately 20% of our students are originating from at least 70 different states, mainly without German citizenship. Thus, TU Berlin ranges high above German average[32]. The estimated same average of international students is also represented in the learning environments of the teaching projects in our project line tu wimi[plus]. What do we know about international students? The study "How Master's students choose institutions. Research on international student segmentation" continues an approach that indicates four distinguishable segments in the cohort of international Master students:
- "Explorers: students with high financial resources and low academic preparedness,
- Highfliers: students with high financial resources and high academic preparedness,
- Strugglers: students with low financial resources and low academic preparedness,
- Strivers: students with low financial resources and high academic preparedness"[33].
For international students, the question of language can be crucial for study success: "English or not English? In November 2014, the leading technical universities of Germany had a

meeting … to discuss the question 'Do engineers need German?' The answer at the end of the day was unambiguously 'yes' … it was perceived that language is not only a basic communication means, but also a framework to develop thoughts, formulate academic questions, and express engineering contents."[34].

Learner diversity
Felder[35] indicates three facets of student diversity that are helpful for reflecting teaching: learning styles, approaches to learning and orientations to studying, and intellectual development. Understanding students and student differences is a crucial basic competence for all academic teaching staff[36]. Even though there are different concepts, sensitivity and awareness of one's own concept and an appropriate teaching activity need to be trained.

Other student groups have to be considered when thinking about suitable study offers for learner diversity: for working students and students with family often a classical full-time study is impossible. Furthermore, 26% of students at TU Berlin originate from non-academic parents and choose engineering studies that therewith are said to be prospective "climber studies"[37].

2.2 Diversity in academic staff development: future TCAs as diverse team members

The special feature of our project tu wimi[plus] is the combination of teaching and disseminating tasks. Team members have to be respectively recruited and additionally qualified for these tasks. Diversity can be also experienced in the composition of the project team. The team of the project is interdisciplinary (chemistry, European economic studies, computer sciences/informatics, transportation (B.Sc.) und aerospace technology (M.Sc.), physical engineering sciences, mechanical engineering (B.Sc. & M. Sc.), electrical engineering, mathematics, also social/human sciences and philosophy) and internationally composed (one member has a migration background). The women and men range in age between approx. 26 and 55 years with different qualification levels (post graduate, PhD students, post-docs).

Our conclusion regarding chapter 1 "Students in teaching and learning environments" and chapter 2 "Future TCAs as diverse team members" leads besides other measures to the use of proven learning styles inventories in engineering education. The following table "Dimensions of Learning and Teaching Styles"[38] illustrates basic principles for the development and reflection of teaching and learning activities:

Preferred learning style	Corresponding teaching style
sensory / intuitive } perception	concrete / abstract } content
visual / auditory } input	visual / verbal } presentation
inductive / deductive } organization	inductive / deductive } organization
active / reflective } processing	active / passive } student participation

sequential		understanding	sequential		perspective
global	}		global	}	

Table 2: Dimensions of Learning and Teaching Styles

According to Felder, students' learning is defined by answers to five questions:
- type of information,
- sensory channel,
- organization of information,
- preference to process information,
- progress toward understanding.

The corresponding teaching style is also defined by answers to five questions:
- type of information,
- mode of presentation,
- organization of presentation,
- mode of student participation,
- type of perspective provided by information presented.

In the context of our project tu wimi[plus], besides individual training, team development in combination with diversity management is crucial. Special diversity competences are essential for successful teams[39]. Which topical fields have to be fostered in a diversity-relevant team development process?
Field 1: Awareness of differences and similarities,
field 2: Impact of these differences and similarities on single team members and the whole team,
field 3: Contribution of differences and similarities to (team) performance,
field 4: Development of differences and similarities to increase (team) performance.
Competences of diversity team development include as a frame: security in dealing with oneself and others, tolerance of ambiguity, dealing with perceptions, empathic communication. The centre is formed by elements of classical team development, e.g. conflict ability, feedback, team cooperation/collaboration, output and performance, continuing education and development.

2.3 Organizational level within our university as context factor

Focusing on teaching and didactic continuing education for teaching in higher education, main characteristics of our project tu wimi[plus] are the obligatory project character and the cooperation of the TCAs as well as the development and management of their teaching projects in the early study phase.
The following table shows a possible structure of four implementation areas for diversity management:
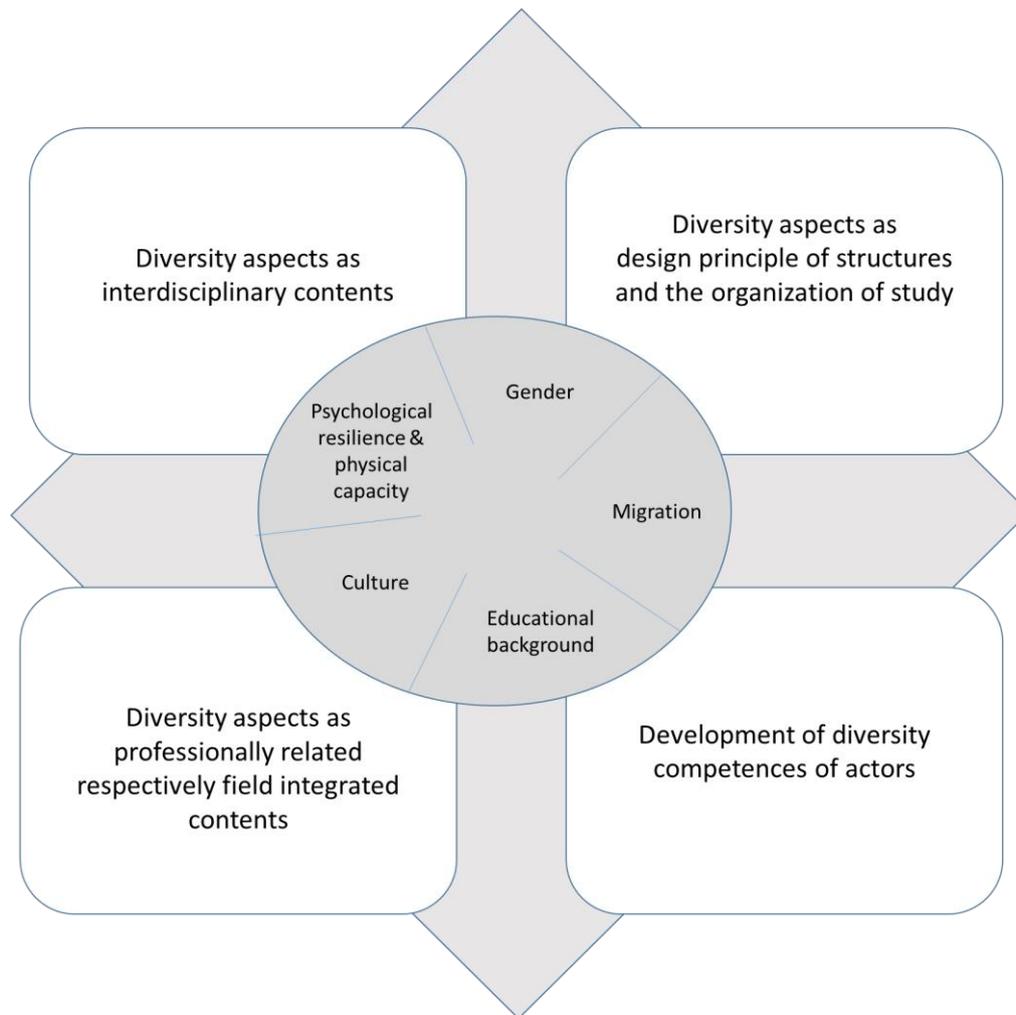
Graph 2: Systematic of four Implementation Areas for Diversity Management[40]

For our project this means that diversity aspects are realized as interdisciplinary content within the different teaching projects. The design principles of study structures and organization are university-wide, not project-specific. There are offers and advisory offices[41]. The development of diversity competence of teaching staff involved in our project is directed towards planning and realization of teaching by the TCAs, also as role models for students. Furthermore diversity aspects need to be integrated into the professional themes.

For the organizational context, the following analysis gives an additional perspective on diversity: "The conditions under which students pursue studies in engineering are as diverse as the objectives and targets under which global engineering study programs are being developed and offered."[42].
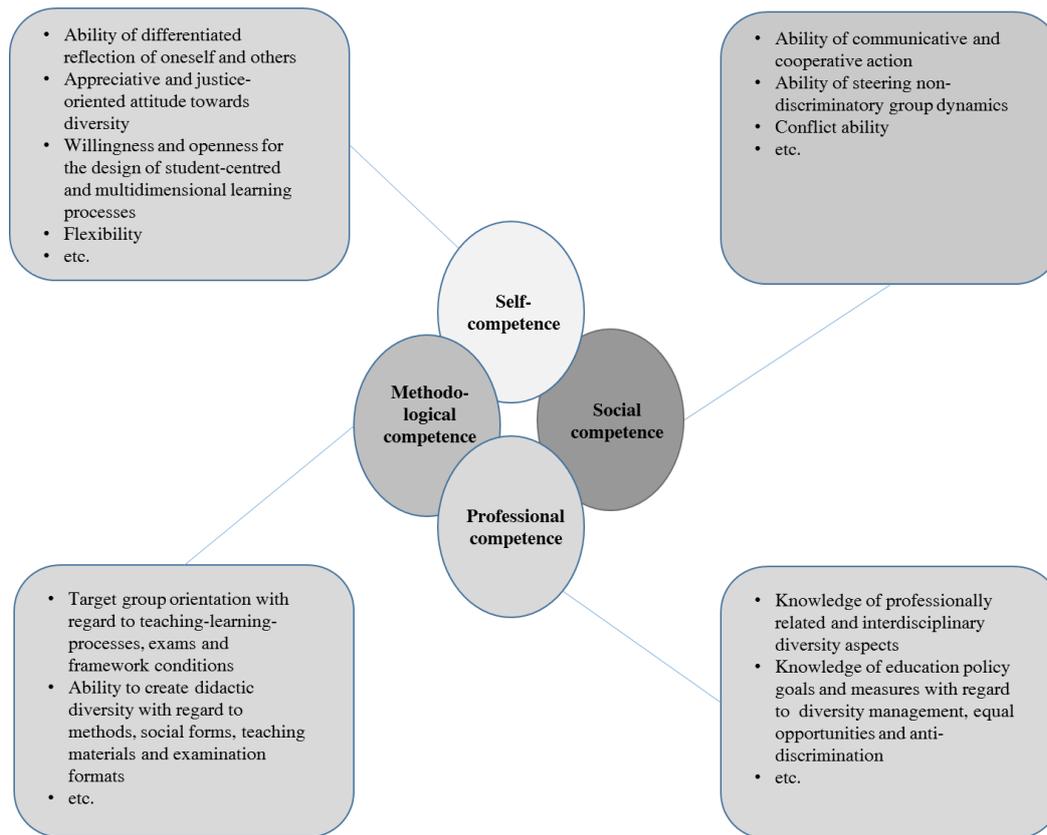
3. Competences

Which diversity competences are desirable to be acquired to work with diverse student groups? The academic teachers and the TCAs are trained in the existing accredited program for (good) teaching and learning and in tailor-made workshops and seminars on request according to their specific needs. Our existing diversity training (gender and intercultural aspects as well as different learning styles and preconditions) has to be (further) developed. This will be outlined in the chapters Contribution and Consequences.

Characteristics of diversity in the context of universities are personality, inner dimension, outer dimension, and organic dimension. Details of these dimensions are specified in the following table:
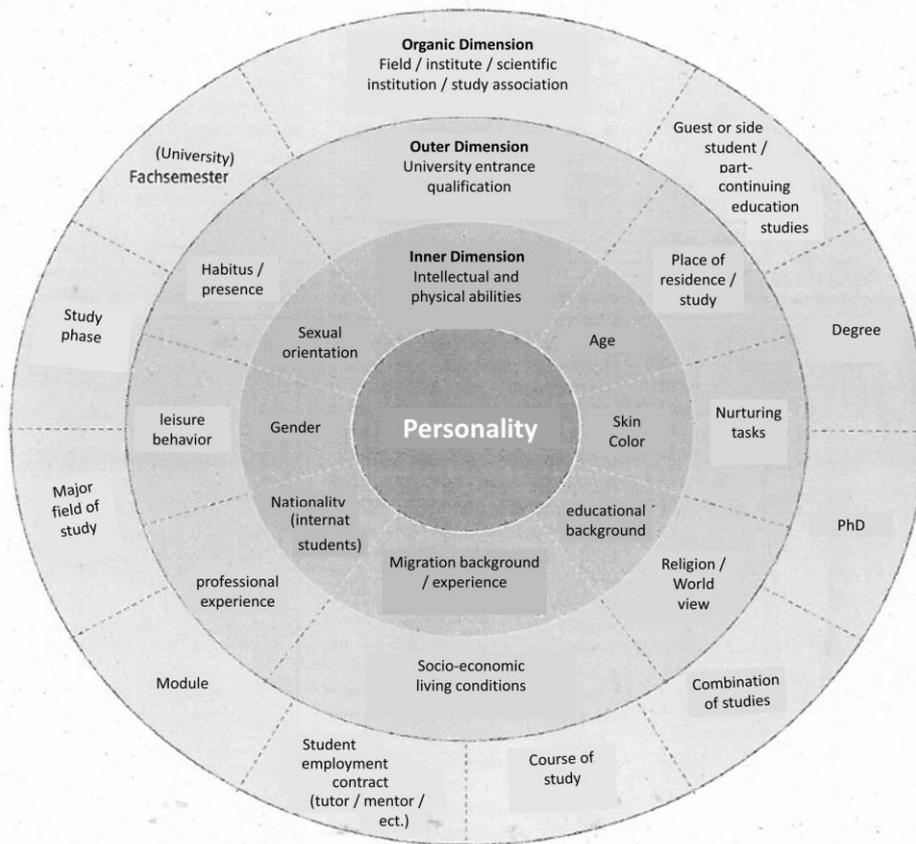
Graph 3: Characteristics of diversity in university context[43]

Diversity competence for university teaching staff is a central component of higher education didactic teaching competence. Diversity competence is based on a holistic approach and, thus, needs to take into account persons and organizations as well as society as a whole. It always includes a subject- and job-related component. Cognitive, affective and behavioral components can be differentiated[44]. It consists of four competence dimensions:

- Ability of differentiated reflection of oneself and others
- Appreciative and justice-oriented attitude towards diversity
- Willingness and openness for the design of student-centred and multidimensional learning processes
- Flexibility
- etc.

- Ability of communicative and cooperative action
- Ability of steering non-discriminatory group dynamics
- Conflict ability
- etc.

Self-competence

Methodo-logical competence

Social competence

Professional competence

- Target group orientation with regard to teaching-learning-processes, exams and framework conditions
- Ability to create didactic diversity with regard to methods, social forms, teaching materials and examination formats
- etc.

- Knowledge of professionally related and interdisciplinary diversity aspects
- Knowledge of education policy goals and measures with regard to diversity management, equal opportunities and anti-discrimination
- etc.

Graph 4: Diversity competence in the context of higher education didactic teaching competence[45]

These before mentioned four competence dimensions describe normative competence requirements respectively the ideal state with regard to professional ability of teaching. The use of one's own personality for teaching: authenticity, commitment, enthusiasm, reflection, and further development is an unseparable element[46].

Fields of diversity implementation are
- diversity aspects as interdisciplinary contents, anchored into the curricula,
- diversity aspects as design principles of structures and study organization,
- diversity aspects as professionally related or subject integrated contents,
- development of diversity competence of the actors in the area of study and teaching (diversity, knowledge and sensitivity)[47].

4. Contribution

The full paper so far has illustrated the previous situation and starting point, the relevance of active learning for diverse student groups, status quo and implementation. It shows the quality of the TCA concept as feasible and sustainable support structure to qualify academic teaching staff for diverse student groups. Finally we draw conclusions, highlighting consequences, success factors and the changes that have to be implemented when diversity aspects are integrated into project- and problem-oriented learning formats.

The implementation of the concept and the structure of permanent and additional new offers in our continuing education programme and project are shown in the following overview:
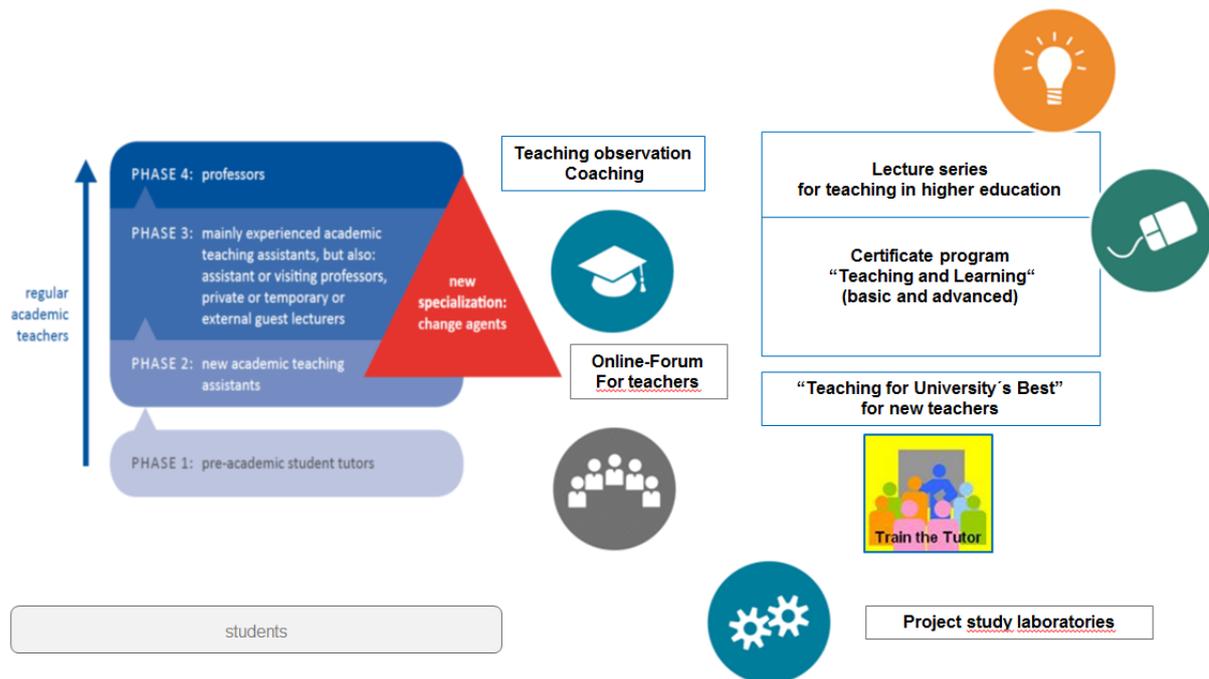
Graph 5: Concept and structure of continuing education program and projects

We have started with diversity related courses in the 1990s in our accredited certificate program "Teaching and Learning" for all regular teaching staff of our university.
Teaching modules covered brain-friendly teaching and learning and learner diversity, gender for teaching in higher education, intercultural aspects of teaching in higher education and planning a seminar/presentation or lecture for an English-speaking audience.
These offers are supplemented by a lecture series about didactics in higher education with 15 relevant lectures on learner heterogeneity, gender, international and intercultural insights[48].
These university-wide offerings can also be attended by TCAs for their teaching competence development in a selective voluntary choice.

For the special qualification TCA in our project tu wimi[plus] , these teaching modules are relevant as they complete the demands of a general competence model for disseminators. For the TCAs' didactic work in their teaching projects in engineering education, diversity and especially gender-related issues are fundamental. For our project this means basically that the realization of diversity aspects in and through context oriented teaching projects is highly promising and has to be seen and realized as a cross-sectional task in the subject, the teaching and the curriculum.

Recommendations for diversity and competence-oriented higher education didactics:
In the context of our teaching projects, this requires diversity-sensitive didactics that enable the TCAs and all regular teaching staff to provide appropriate teaching and learning arrangements and to develop the engineering students' diversity competences for employability. More relevant common themes[49] have been focused on engineering diversity relevant aspects and tailored for our project: Learning objectives need to consider different areas of (diversity) competences. The didactic concept should offer different choices with regard to learning methods, exams and assessment tasks. Learning assignments need to

consider different types of social forms and their characteristics. Learning materials should include diverse forms. The didactic concept needs to include learners' diversity relevant documentation to support learning outcomes for diverse students. The didactic concept should support students´ self reflection of their own learning process.

The following curriculum for TCAs[50] shows in bold letters the relevant diversity themes. They are considered as a cross-sectional task during all semesters with an emphasis in the 3rd semester.

Time	Continuing education	Tailor-made offers	Support program
1st semester	introductory course	kick-off workshop	coaching, peer observation of teaching, project jour fixe (implementation, to be continued in the following semesters)
2nd semester	brain-friendly learning, activating teaching methods, project work and problem-based learning	planning workshop for teaching projects	workshop for reports
	imparting knowledge and presentation techniques in lectures	development of a dissemination workshop	workshop for writing: attractive advertising of innovative course offers
	classical and digital media in the teaching process	digital media: participatory tools	online forum for exchange of experiences and self-study
	assessment and grading	workshop: grading papers and tests	lectures on examination techniques
3rd semester	moderation of learning groups	workshop: reflecting dissemination work	the student generation today: their goals and possibilities
	managing difficult teaching and learning situations	**workshop: active methods for diverse classrooms**	**lecture on learners' diversity**
	feedback and quality management	evaluation: activity-oriented questionnaire	preparation of self-evaluation and reflection: teaching portfolio
	research based teaching and learning	workshop: inverted classroom techniques	workshop: fund-raising for teaching projects
4th semester	development of key competences	results of teaching projects and dissemination activities	workshop: networking for lecturers
	studying technique and work organization	planning of future strategies	knowledge management workshop: handing over the baton

Table 3: Model curriculum for (teaching) change agents

"Semester 1 starts with the introductory course for teaching activities and the kick-off workshop for the project members. At the same time, the permanent supporting events like coaching, peer observation of teaching and project jour fixe are implemented.
Semester 2 concentrates on the two main lines of teaching, following results of findings on brain-friendly learning: activating teaching methods, project work and problem-based learning, as well as imparting knowledge, and presentation techniques in lectures and large classes. The basic aspects and methods of the change agents' teaching projects and their disseminating tasks are planned and prepared. This is framed by techniques for the use of classical and digital media as well as the application of assessment and grading. The consolidation is reached by tailor-made individual offers. A report and material for promotion are developed.
Semester 3 is focused on moderation and difficult situations in learning groups as well as on diverse students' characteristics. The link between research and teaching is addressed.

With regard to quality management, the teaching projects and dissemination workshops are evaluated and modified where necessary. Furthermore, self-evaluation of teaching key competences with a written teaching-portfolio is fostered.

During semester 4, networking and handing over the baton are initiated. Preparations for the implementation of the teaching project start. This and planning future strategies (also based on former fundraising activities) will be the main challenge for all change agents. This model curriculum is finalized after four semesters teaching and qualifying as a change agent. It is followed and supplemented by individual and team coaching, didactic monitoring of the teaching projects, jour fixe- and networking meetings as well as tailor-made offers according to individual demands."[51]

For TCAs, after a basic training about definition, prejudices, and challenges of diversity in a first workshop, this should be focused especially on gender diversity (workshop 2) and intercultural diversity (workshop 3) as these are the most relevant aspects in our context. Next steps of implementation are the certificates for the acquired individual profiles.

5. Conclusion

We strongly feel that relevant aspects and elements for diversity training within our TCA-curriculum should consider the following aspects and consist of the following elements. Continuing education training formats for diversity competence mainly refer to three practical perspectives:
- sensitivity trainings for reflection of self-competence,
- higher education pedagogical competence,
- individual dimensions of diversity, for instance barrier-free higher education didactics.

An attitude cannot be changed by selective course offers, but needs to be critically reflected within the frame of everybody´s individual, educational biography and as a process of lifelong learning. Therefore, it is the responsibility of each individual. By using gender-related contents, it is also an educational, an interdisciplinary and a social approach that is enhancing key competences for each profession. Workshop concepts should also focus on the potential of diversity and the training of diversity competences, e.g. how to develop chances and possibilities of diversity[52].

The recently revised concept of our workshop "gender for teaching" covers beside an introduction, the status quo, competences, basics like terms, stereotypes, and approaches, hidden curricula and perceptions of teaching staff, learner and teacher diversity, consequences and possibilities for implementation in teaching, and an outlook[53]. Themes of our intercultural workshop cover cultural guidelines, intercultural misunderstandings, explanations, and solutions for teaching.

It is essential for diversity workshops, to integrate gender sensitivity into the planning of learning environments (e.g. selection of contexts, learning materials, gender appropriated language) and to discuss methods for a change of the learning culture (many different active methods so foster equal participation). The more we apply didactic principles that demand plurality of methods, interactivity and e-learning environments, the more we address learner diversity and improve diversity sensitive teaching.

Some actions and conditions required to implement this learner centered and diversity sensitive approach to engineering education are: a commitment of the HEI to enhance the quality and retention rates of engineering education by taking diversity into account, to foster active learning, goal-oriented recruiting and qualification of teaching staff for these aspects by

sensitizing them and integrating relevant new topics into the curricula, diverse country-specific and international approaches and variations of curricular and tailor-made offers as well as sustainable financial support for the continuous and focused pedagogical qualification of teaching staff.

References

[1] Hahm, E. (2015): Diversity-Kompetenz im Bereich der Hochschullehre – ein zentraler Baustein hochschuldidaktischer Lehrkompetenz. In: Greifswalder Beiträge zur Hochschullehre. Vermittlung von Schlüsselkompetenzen in der polyvalenten Lehre. Ernst Moritz Arndt Universität Greifswald: Ausgabe 5, November, pp. 7-23, here p. 8.

[2] Heywood, J. (2005): Engineering Education. Research and Development in Curriculum and Instruction. Hoboken, New Jersey: John Wiley & Sons.

[3] Powell, R. (2001): Straight Talk. Growing as Multicultural Educators. New York: Peter Lang Publishing.

[4] IntlUni Erasmus Academic Network (2015): http://intluni.eu/ (13.01.2016).

[5] see [4], here p. 5.

[6] see [4], here p. 6.

[7] HRK – Hochschulrektorenkonferenz (Ed.) (2013): nexus impulse für die Praxis. Nr. 3 Vielfalt gestalten und Chancen nutzen – Diversität in Studium und Lehre. Bonn: Projekt nexus – Konzepte und gute Praxis für Studium und Lehre (1. Aufl.), pp. 2-7, own translation, here p. 2.
This map is widely acknowledged and has been developed by several authors: compare Bommers/Nietschke 2012 following Gardenswartz/Rowe 1998, also compare Buß 2013, p. 3 and Hahm 2015, p. 10.
Boomers, S., Nitschke, A.K. (2012): Diversität und Lehre – Empfehlungen zur Gestaltung von Lehrveranstaltungen mit heterogenen Studierendengruppen. http://www.mi.fu-berlin.de/wiki/pub/Stuff/GenderDiversity/Diversitaet_und_Lehre_Empfehlungen_zur_Gestaltung_von_Lehrvera nstaltungen_mit_heterogenen_Studierendengruppen.pdf (27.01.2016).
Gardenswartz, L., Rowe, A. (1998): Managing Diversity: Diversity Teams at Work. New York: McGraw-Hill (Revised Edition).

[8] KomDim Professionalisierungsprogramm für DiM-Akteur*innen in Lehre und Studium (2016): German diversity competence network. http://www.komdim.de/profi-ls/ (03.03.2016).

[9] see [7].

[10] Wild, E., Esdar, W. (2014): Eine heterogenitätsorientierte Lehr-/Lernkultur für eine Hochschule der Zukunft. Fachgutachten im Auftrag des Projekts nexus der Hochschulrektorenkonferenz, gefördert vom Bundesministerium für Bildung und Forschung. Bonn: Juni 2014, here pp. 63-72. http://www.hrk-nexus.de/fileadmin/redaktion/hrk-nexus/07-Downloads/07-02-Publikationen/Fachgutachten_Heterogenitaet_Wild.pdf (27.01.2016), here pp. 63-72.

[11] Baumert, B. (2012): Auch Hochschullehrende sind nur Menschen. Ein hochschuldidaktischer Blick auf die Diversität von Lehrenden. In: Journal Hochschuldidaktik. Diversität in der Hochschule. Technische Universität Dortmund: Heft 1-2, pp. 19-22, here p. 20.

[12] Hahm, E. (2015): Diversity-Kompetenz im Bereich der Hochschullehre – ein zentraler Baustein hochschuldidaktischer Lehrkompetenz. In: Greifswalder Beiträge zur Hochschullehre. Vermittlung von Schlüsselkompetenzen in der polyvalenten Lehre. Ernst Moritz Arndt Universität Greifswald: Ausgabe 5, November, pp. 7-23, here p. 9.

[13] Ars Legendi (2016): http://www.hrk.de/themen/lehre/arbeitsfelder/ars-legendi/ (13.01.2016).

[14] Charta der Vielfalt (2011):
http://www.charta-der-vielfalt.de/unterzeichner/unterzeichner-der-charta-der-vielfalt/zeige/technische-universitaet-berlin.html (03.03.2016).

[15] Diversity Audit (2016): http://www.stifterverband.org/diversity-audit (13.01.2016).

[16] TU Berlin (2011): University Mission. http://www.tu-berlin.de/menue/about_the_tu_berlin/laws_directives_guidelines/university_mission/parameter/en/ (31.01.2016).

[17] Lucht, P., Mauss, B. (2015): Teaching research-based gender competencies in STEM (German: MINT): The study program GENDER PRO MINT at the Technische Universität Berlin. 43rd Annual SEFI Conference June 29-July 2, Orleans, France.

[18] Steinbach, J., Jansen-Schulz, B. (Hrsg.): Gender im Experiment. Gender in Experience. Ein Best-Practice Handbuch zur Integration von Genderaspekten in naturwissenschaftliche und technische Lehre. Berlin: Universitätsverlag der TU Berlin. Also compare http://www.tu-berlin.de/owl (29.01.2016).

[19] Wendorf, G., Wemheuer, C., Raue, C. (2012): Heterogenität in Studium und Lehre. In: Zentrale Frauenbeauftragte der TU Berlin (Hrsg.): news – Frauenpolitisches Forum an der TU Berlin, Sommersemester, p. 17-19. here p. 17, own translation.

[20] Wendorf, G., Wemheuer, C., Raue, C. (2012): Heterogenität in Studium und Lehre. In: Zentrale Frauenbeauftragte der TU Berlin (Hrsg.): news – Frauenpolitisches Forum an der TU Berlin, Sommersemester, p. 17-19, here p. 17, own translation.

[21] TU Berlin (2011): Erste Klasse für die Masse. Antrag der TU Berlin zum Bund- und Länder-Programm für bessere Studienbedingungen und mehr Qualität in der Lehre. http://www.tu-berlin.de/fileadmin/fg14/HSP_III/Gesamtantrag.pdf (27.01.2016), here p. 6, own translation.

[22] see [19], here p. 19, own translation.

[23] Freeman, S., Eddy, S.L., McDonough, M., Smith, M.K., Okoroafor, N., Jordt, H., Wenderoth, M.P. (2014): Active learning increases student performance in science, engineering, and mathematics. In: Proceedings of the National Academy of Sciences. Vol. 111 (23), p. 8410-8415, Source: http://www.pnas.org/content/111/23/8410.full (29.12.2015).

[24] among others: Antonio, L.A., Chang, M.J., Hakuta, K., Kenny, D.A., Levin, S., Milem, J. F. (2004): Effects of racial diversity on complex thinking in college students. In: Psychological Science, 15 (8), pp. 507-510.
Nemeth, C.J., Wachtler, J. (1983): Creative problem solving as a result of majority versus minority influence. In: European Journal of Social Psychology, Vol. 13 (1), pp. 45-55.
Terenzini, P.T., Cabrera, A., Colbeck, C., Bjorklund, S., Prente, J. (2001): Racial and ethnic diversity in the classroom: Does it promote student learning? In: The Journal of Higher Education, Vol. 72 (5), pp. 509-531. Also compare [26], here p. 5.

[25] Häuptle-Barceló, M. (1999): Lernstrategien und autonomes Lernen. In: Edelhoff, C., Westkamp, R. (Eds.): Autonomes Fremdsprachenlernen. München: Langenscheidt, pp. 50-61.

[26] Buß, I. (2013): Diversity im Kontext von Organisationsentwicklung: Lernprozesse in den Mittelpunkt stellen. In: Berendt, B. , Fleischmann, A., Schaper, N., Szczyrba, B., Wildt, J. (Hrsg): Neues Handbuch Hochschullehre. Lehren und Lernen effizient gestalten. Berlin: Raabe Fachverlag für Wissenschaftsinformationen, J 3.9, here p. 8.

[27] compare [1] , here p. 13, own translation.

[28] Schaare, F., et al (1993): "Ich will nicht gefördert, ich will nur nicht behindert werden." Zur Situation von Studentinnen an technischen Fachbereichen. Berlin: Zentrale Frauenbeauftragte der Technischen Universität (unv. MS), own translation.

[29] TU Berlin (2015): Zahlen und Fakten. http://www.tu-berlin.de/menue/ueber_die_Tu_berlin/zahlen_fakten/#91200 (04.03.2016).

[30] Bessenroth-Weberpals, M. (2008): Geschlechtergerechtes Lehren und Lernen von Physik: Reflexive Koedukation und Physik im Kontext für das Studium. In: Schwarze, B., David, M., Belker, B.C. (Eds.): Gender und Diversity in den Ingenieurwissenschaften und der Informatik, pp. 137-144. Bielefeld: UniversitätsVerlagWebler.

[31] Curdes, B. (2008): Genderaspekte und didaktische Konzepte für Mathematik in technischen Studiengängen. In: Schwarze, B., David, M., Belker, B.C. (Eds.): Gender und Diversity in den Ingenieurwissenschaften und der Informatik, S. 145-152. Bielefeld: UniversitätsVerlag Webler.

[32] see [19], here p. 17, own translation.

[33] Lu, Z., Schulmann, P. (2015): How Master's students choose institutions: Research on international student segmentation. World Education Services, Research Report 07, October, here p. 1. http://wenr.wes.org/wp-content/uploads/2015/10/WES_HowMastersStudentsChooseInstitutions_ResearchInternationalStudentSegmentation.pdf (13.01.2016).

[34] Hunger, A., Werner, S., Dippel U. (2015): Diversity in Engineering Education: Good or Evil for International Programmes? 43rd Annual SEFI Conference June 29-July 2, Orléans, France, here p. 3. http://www.sefi.be/conference-2015/CHAP%2013.%20Diversity%20in%20Engineering%20Education/56528.S.WERNER.pdf (13.01.2016).

[35] Felder, R.M., Brent, R. (2005): Understanding Student Differences. In: Journal of Engineering Education, 94 (1), p. 57-72, here pp. 57-58.

[36] Felder, R.M., Brent, R. (2005): Understanding Student Differences. In: Journal of Engineering Education, 94 (1), p. 57-72.

[37] see [19], here p. 17.

[38] Felder, R.M. (1988): Learning and Teaching Styles in Engineering Education. In: Engr. Education, 78 (7), p. 674-681 with Author's Preface June 2002, here p. 675.

[39] Lüthi, E., Oberpriller, H. (2009): Teamentwicklung mit Diversity Management. Methoden-Übungen und Tools. Bern/Stuttgart/Wien: Haupt, here p. 28, 30, 51.

[40] Treeck, T. van, Linde, F., Winter, S., Wegrzyn, E. (2013): Vorwort. In: Heuchemer, S., Klammer, U. (Eds.): Kompendium für Diversity Management in Studium und Lehre. Beratung – Personalentwicklung – Hochschulsteuerung. Berlin, Stuttgart: Raabe (Band 1), p. V-XI (see p. VIII for different preparing authors).

[41] Die Zentrale Frauenbeauftragte: Checkliste zu Gender- und Gleichstellungsaspekten (2013): http://www.tu-berlin.de/fileadmin/i31/Checkliste_Gender_Studiengaenge_Endversion.pdf (03.03.2016).

[42] see [34], here p. 7.

[43] see [7], here p. 3, own translation.

[44] see [1], pp. 16-17.

[45] see [1], p. 20.

[46] see [11], here p. 21.

[47] see [1], here p. 13, own translation.

[48] 2009-2015

1. Single themes are:

Problems and perspectives when dealing with international students

"I surely treat everybody equally!" Gender studies/gender research in engineering sciences – consequences for (higher education?) teaching

International, project-based engineering education

Learning-related diversity and its consequences for (higher education?) teaching

How to convey, develop, and assess interdisciplinary competences

Interdisciplinary projects in the introductory (study) phase

2. Central semester topic: Diversity and young scientists development

Students are different. What does this mean for good teaching? (in higher education)?

Good teaching (in higher education). What does diversity sensitive teaching mean?

Diversity in engineering education: teaching, research, organization

3. Central semester topic: Internationalisation in study and teaching

How to teach, learn, and live: Internationalization at TU Berlin

Quality and internationalization of (higher education) teaching from a European perspective.

Intercultural higher education development and culturally sensitive higher education didactics

Internationalization of the curriculum – obstacles and enablers to implementation

http://www.zewk.tu-berlin.de/v_menue/wissenschaftliche_weiterbildung/hochschuldidaktik/hochschuldidaktische_ringvorlesung/ (03.03.2016)

[49] Spelsberg, K. (2013): Diversität als Leitmotiv. Handlungsempfehlungen für eine diversitäts- und kompetenzorientierte Didaktik. Eine explorative Studie im Kontext einer Kunst- und Musikhochschule. Münster u.a: Waxman, here p. 246. Also compare [1], p. 15.

[50] Rummler, M., Nikol, P. (2015): Continuing Education and Training of Academic (Teaching) Staff and (Teaching) Change Agents for Engineering Education: Concept and Program for Developing Teaching and Improving Learning at Technische Universität Berlin/Germany. Conference Proceedings for ASEE's 122th Annual Conference & Exposition "Making Value for Society" in Seattle, WA/USA (14.-17. June 2015) http://www.asee.org/public/conferences/56/papers/14241/view (07.07.2015).

[51] compare [1], here p. 21.

[52] compare [39], here p. 169.

[53] Rummler, M., Jordan, P. (2008): Gender für die Lehre. Ein Weiterbildungsangebot für Lehrende der TU Berlin. In: Steinbach, J., Jansen-Schulz, B. (Hrsg.): Gender im Experiment. Gender in Experience. Ein Best-Practice Handbuch zur Integration von Genderaspekten in naturwissenschaftliche und technische Lehre. Berlin: Universitätsverlag der TU Berlin, pp. 51-82.

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http://www.zewk.tu-berlin.de/v-menue/wissenschaftliche_weiterbildung/hochschuldidaktik/tu_wimi_plus/