Chapter #7

ENTRY INTO GREATER DIVERSITY – INTERDISCIPLINARY SCIENTIFIC-TECHNICALLY PROJECT LABORATORIES

New Learning Settings in a Globalized World

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ABSTRACT
Since 2013 HTW Berlin has been working with a special form of interdisciplinary project laboratories. This kind of learning process is characterized by very active participation of the students and it creates open spaces and opportunities for international cooperation. Students exert their influence on the contents of the projects and lectures during the course. The teaching process based consequently on partnership of the students and the teaching staff. The courses consist of students from different departments of the HTW Berlin. Participants are supervised by scientific-technically oriented interdisciplinary professional staff. Thereby the learning setting intends to motivate Bachelor (BA) and Master (MA) students to conduct independent development and research, to apply new form of presentation skill and to engage on an international level scientific discussion. Interdisciplinary project laboratories courses are particularly suitable for new methods of transcultural learning. The methods and goals of the courses are designed to be carried out on the basis and demands of a world with grown mobility and immigration.

Keywords: interdisciplinary project laboratory, culture-sensitive strategy, transcultural learning, soft skill exercising, digital storytelling, international cooperation.

1. INTRODUCTION

For the last several decades, increasing globalization and higher mobility have facilitated the transnational cooperation between universities and research institutes. As the knowledge transfer and communication grew larger, global topics have become relevant factors in learning settings, optimizing an international access to new forms of teaching and learning and including topics like how to address sustainable development, energy and water for all, climate change and poverty eradication using innovative technologies and green ideas (Farach et al., 2015).

The German Hochschule für Technik und Wirtschaft Berlin (HTW Berlin) pursues a globalization approach (HORIZON), creating opportunities to gather experience abroad and maintaining international cooperation in the teaching and research (HORIZON, 2016). At the same time HORIZON stands for expanding the own horizon, changing perspectives and personal development. The practical goal of this strategy is to foster internationalization at HTW Berlin, developing possibilities and opportunities for the students to gain intercultural skills and international experiences, by stimulating the contact and interaction among students of different nations and cultures at HTW Berlin (HTW-INTEGRA, 2017).

Within the HORIZON, opportunities are provided for HTW members and students to collaborate with an international partner institution at different levels. According to a main research/project theme proposed by the group of 2 to 6 students jointly develop and pursue research projects over a period of one or two semesters. In doing so, the participating students collaborate both in small teams at their individual discipline or across the disciplines. In order to enhance this exchange of ideas, questions, and knowledge over the span of time and geographical borders, two ways of communication are combined: the 'classic' methods of onsite face-to-face group work and new digital forms of communicating and e-learning (moodle work space).

2. BACKGROUND / CONCEPTUAL FRAMENWORK

In order to create innovative forms for teaching Department I of HTW Berlin has launched the interdisciplinary project laboratories. The first one is called Project Laboratory (ProLab) course, the second one is called Research and Development Laboratory (R&DLab) course [reference]. Participants will be addressing their own questions, challenging identified matters of fact, finding their own solutions and thereby acquiring knowledge. From the didactic point of view, these HTW Labs are less teaching special knowledge in the classical sense of instruction, but rather give an opportunity for students to participate actively in innovative research trends and to actively acquire, try out and develop new methodological and subject-based knowledge and skills (Følstad, 2008). The academic staff involved in these projects therefore act as mentors, coaches, and facilitators rather than instructors and teachers. From the interdisciplinary point of view, the educational objectives for the participating BA and MA students are: research experience, disciplinary reflexion on co-design (insights into different research-cultures, like African digital storytelling) and theoretical approaches/new methods (design thinking), language competence (team-teaching), and intercultural competence (Fog, 2010).

2.1. Broad access to interdisciplinarity

At the HTW, Berlin, we offer students new forms of elective courses. Both courses arose within the context of natural science and technology disciplines. The subject matter of these courses isn't the knowledge transfer of a special scientific discipline rather, course participants should practice important soft skills (see figure 1). They get a methodological background and learn general fundamental methods to solve different kind of complex problems and challenges. Interdisciplinary team work and cross-cultural competences are defined targets. The participants favour a pragmatic approach in order to identify the need for truly useful settings and new technologies (Stauffacher, Walter, Lang, Wiek, & Scholz, 2006).

That's why these courses are open to all students (all terms and BA and MA degree programs). That means students with different specialities (Engineering, Information Technology, Economics, Life Sciences, Culture & Design) come to work and learn together in interdisciplinary and term-overlapping structures.

Figure 1.
Scientific-technically project laboratories - Design Science Approach.

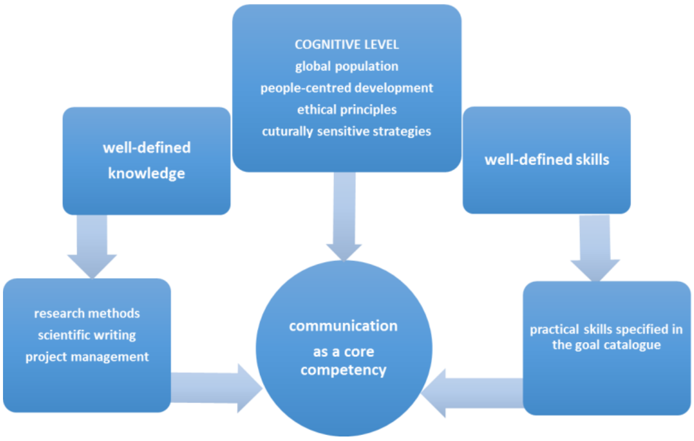
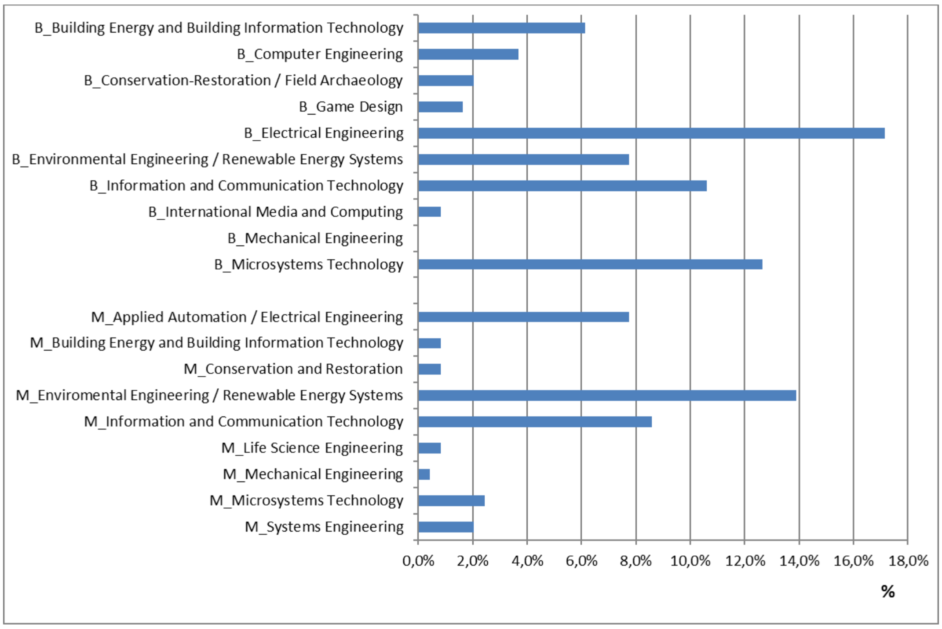


Figure 2 illustrates the composition of the programs involved in the courses. Over hundred participants took place on these elective courses during the last eight semesters. They came from different programs. The majority of the participants are enrolled in a BA program which accounts 56 %, and the remaining 44% participants are MA students. The number of participants of these elective courses showed a high rate of increase with only about 5 % dropout rate, which the lowest as compared to other courses with 15 to 20 % dropout rate (Bailleu, Kröger, Menge, & Münchow-Carus, 2015).

Figure 2.
HTW Berlin programs where the participants came from.



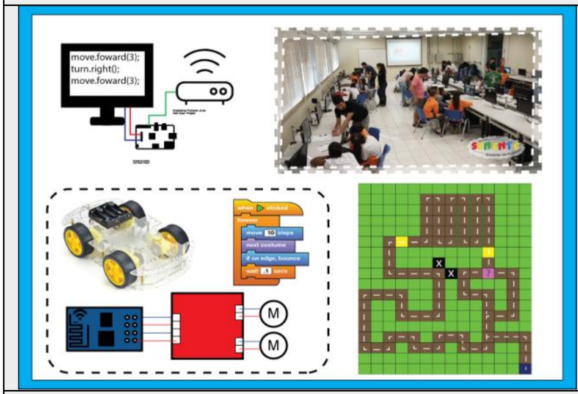
2.2. Structure and workflow

At the beginning of HTW ProLab and R&DLab students introduce themselves and present their first project ideas (Bailleu et al., 2015). The mentioned internationalization strategy requires close cross-border coordination and adapted learning settings [reference]. The courses are running in German, English or bilingual with the help of native speakers as team teachers. However, when working with different topics and international levels, the teaching staff needs to be on one hand observant as regards the information collection and bibliography research, development of solutions, presentation and dissemination of the projects and on the other hand direct mentor for different groups and individuals.

The realization effort of the ideas is discussed between course participants and the teaching team (Marr, 2010). Ideas concerning the implementation time, budget and scientific contents requirements of the course have got accepted. Figure 3 shows an example of an integral part of the course: the budget planning process.

Figure 3.
Example of student´s budget planning.

EDUCATIONAL ROBOTS - SOLUTION FOR A BETTER WORLD



Materials procurement process: "At first we are aiming for a very simple robot, making it cheap for easy testing and implementation" (Luiz Alves)

1. ESP 8622

(WIFI module)

2. H-Bridge

3. Distance Sensor

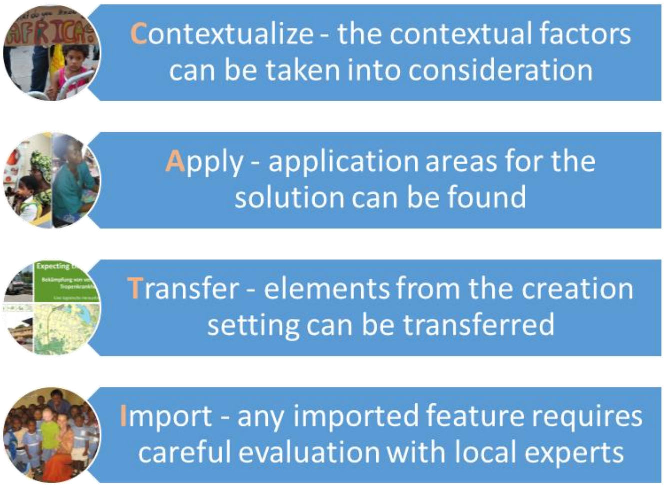
4. Motors and Wheels

Pictures by courtesy of Luiz Alves (https://www.techenergy-for-africa.de/intiative-nachhaltigkeit/technik-für-den-menschen/ (accessed 2017 August 17)

3. TEACHING METHODS AND EVALUATION

Worldwide learning settings still are often characterized by traditional learning methods, which rely largely on the memorization of information. In these setting creativity is often discouraged rather than encouraged (Florida, 2002). The teaching method of the courses ProLab and R&DLab, as already described before (Kröger, Bailleu, & Münchow, 2016, Bailleu et al., 2015). It seems that the practice-orientated work is more powerful than traditional forms of teaching as it allows international students to be presented in new ways where visuals and interactivity can add to and enhance the learning experience (Følstad, 2008). To evaluate the transferability of student's work in different international settings, we use the CATI model to analyse the design and the functionality from different perspectives (Vesisenaho, 2007). Figure 4 shows the CATI model (model for technology transfer: contextualize, apply, transfer, import) as the underlying concept.

Figure 4.
CATI as underlying culturally sensitive concept.



The teaching method is practice-orientated project work instead of the usual lectures or classical tutorials. Classical lectures and tutorials are offered on demand in the courses only as an additional support. The participants are supported by several laboratory engineers and other staff members, whenever relevant expertise and instruction are needed. The key experience was that in international groups the participatory design process is more important than the production itself (Hecht, & Maas, 2008).

4. REALISATION AND RESULTS

When designing learning environments for the next generation students with an international context, what are the advantages of the interdisciplinary project laboratories? This chapter presents our main results and experiences.

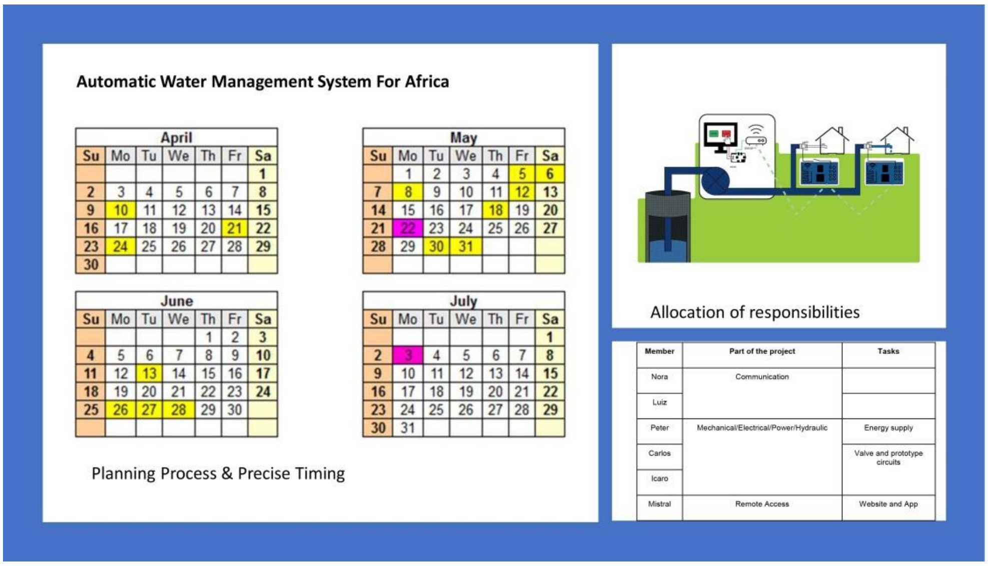
Normally, an individual introduction for every participant and project proposals are submitted by the students and by the teachers during the first unit. This unit is the only one with compulsory attendance for all participants of the courses. The very exceptional and interesting ideas to be realized in promising projects are listed at the beginning of a course.

4.1. Team building, support and project management

During the first unit students get short lectures in project management, team building, design thinking, efficient communication structures, and presentation skills. The realization effort of the ideas is discussed with all the course members and the teaching team. Ideas meeting the timeline, budget and scientific contents requirements of the course get accepted. During the team building process the students form project groups. As an accompanying support, the teach-team offers elective units on demand, for instance: brainstorming sessions (Mind Mapping), CAD-tools and CAD-Systems (CAD computer-aided design), EDA-tools (EDA: electronic design automation), Programming (LabVIEW), Data analysis, Software for Project planning and controlling.

A specific example (figure 5) may be used to demonstrate the overall planning, the precise timing and the allocation of responsibilities to the international group of students (Brazil, Cameroun, Germany, Spain, pictures by courtesy of the whole group).

Figure 5.
Planning process and allocation of responsibilities.



4.2. Examination & performance skills

Examination of students consists of the individual oral presentation and discussions. In addition, there is a practical presentation (demonstration) of the project results by the project team. Furthermore, the project teams have to deliver a written project documentation consisting of description of the aims of the project giving details about project partners, implementation region, project term and budget and role allocation in the project. In the meantime, real interaction and cooperation with abroad students will give opportunity to the HTW Berlin students to expose their projects to other students during a short period and to get values feedback.

4.3. New role perception of the teaching staff

As the main result, it can be noted that the courses are characterized by more differentiated role perception, but also deeper intercultural understanding. In addition to the monitoring of the projects, the teaching and administration staff ensures the smooth running of the courses: room and laboratory management combined with other tasks to ensure that excellence are provided to the expected level. The professors and laboratory engineers work as senior consultants for all projects in both consecutive courses.

4.4. Spectrum of project results

The results of the projects are widely spread. An overview of projects realized within the scope of courses ProLab and R&DLab during last years are given on our website (Kröger, 2017) and selected examples are described in several conference papers (Bailleu et al., 2015, Kröger et.al., 2016 and Bailleu, Kröger, & Münchow., 2016).

Often the students focus their practical projects to their interests in energy generation. For instance, a project group inspired by existing concentrated solar power plants (CSPs) builds a working model of such a power plant. CSP version vs the realized model is shown in figure 6. A field of mirrors concentrates sunlight onto a solar power tower. The realized model produces energy to heat up water.

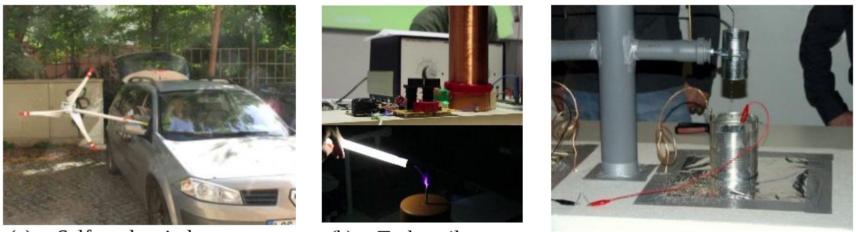
Figure 6.
CSP-Concentrated solar power plant.

(a) Inspiration of the project idea: A concentrated solar power plant (CSP) in Nevada (USA)

(b) Model of a concentrated solar power plant (CSP)

Other practical project results in this content with high electrotechnical aspects were a self-made wind generator, a Tesla coil and an electrostatic generator based on a Kelvin water dropper (see figure 7). Such results are impressive considering to the scheduled workload for a course (100 hours) and the small budget (50 €) for a project group (Bailleu et al., 2015).

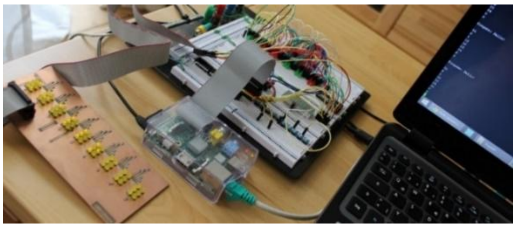
Figure 7.
Selected examples with high electro technical aspects.



(a) Self-made wind generator (b) Tesla coil (c) Kelvin water dropper

Often the students look enthusiastically for solutions in context of biomedical applications during the project laboratories. An example of this is an e-book-reader with Braille lettering output (figure 8).

Figure 8.
E-book-reader with Braille lettering output.



It is possible to translate any text into Braille with the realized setup shown on the left hand side of figure 8. You can see 9 segments, written is “hallo”. The Braille display is symbolized by LED cells.

Many ideas for projects are created by the students completely unassisted. Other projects are proposed by the teaching staff or are found (mostly by the students themselves) on websites or books, as for example how to build a Stirling engine from an ordinary food can and a simply recreating wooden part (Viebach, 2010) or the idea for the project “fridge in a vessel”, which is suggested in a very nice booklet with the (translated) Name “inspirations instead of wastes” (Kuhtz, 2012) and (Mathieu, 2006-2016).

It is not possible to illustrate the complete diversity of the projects. Some of our students combine their interests for music and for modern technical opportunities during the project laboratories. Examples of such projects are a guitar amplifier (without a figure), a Theremin (figure 9) and a luminous cube realized with a micro controller to control the light phenomenon by classical music (figure10).

Figure 9.
Students playing their Theremin.

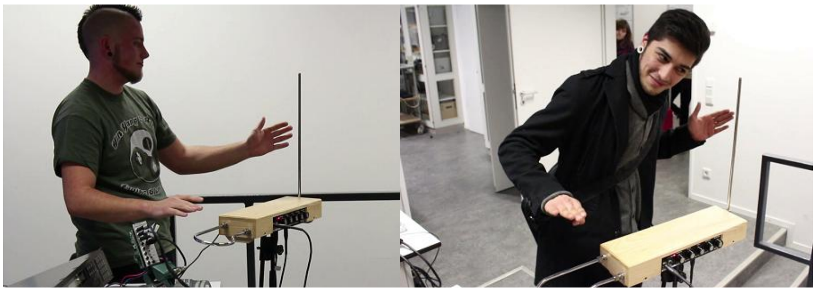
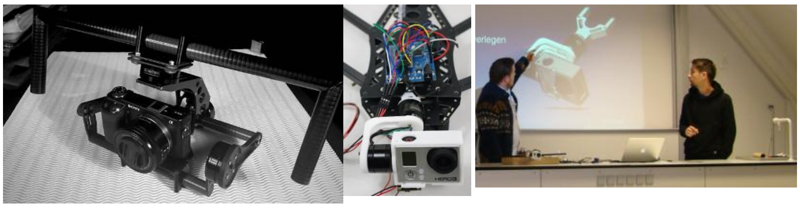


Figure 10.
Luminous cube realized with micro controller.

The presentations of instrument-based results were always very impressive and funny shows.

Even industrial products are results of the courses, for example the two camera gimbal projects (figure 11). The left one camera-gimbal was realized for manual use in helicopters. Finding an industrial partner made the development and the prototype possible. It became an industrial duplicated part by now. The other one was realized for automatic use of a GoPro-action-cam.

Figure 11.
Camera gimbals.



(a) Handheld gimbal for manual camera use in helicopters

(b) Go-pro- action-cam gimbal version for automatic camera use and

(c) Presentation of the gimbal project results

Another group developed additional bike displays during two consecutive courses. A group of only two students developed hardware for bikes and an App for Windows Mobil which provides driving information of a motorcycle (figure 12). A smart phone is used additionally to the normal bike display. The result of this project appears almost like a professional development.

Figure 12.
Driving information for bikers.

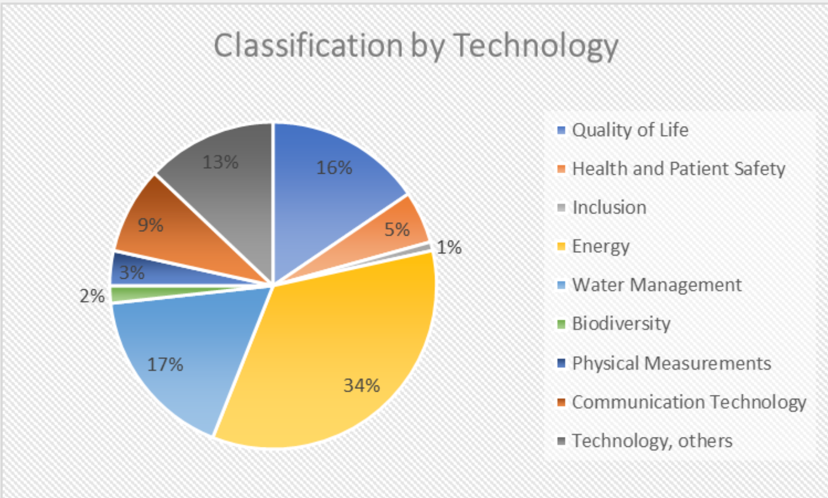
Multiple benefits derive from the presented practice orientated project work in interdisciplinary term-overlapping structures in more than one case.

Some of results are used as demonstrators in the physics lesson of several Bachelor's degree programs (e.g. figures 6-8). This means students learn by themselves and produce learning tools for other students within the same process. Other one are used to promote the technical courses at our university by funny and popular results of our students (e.g. projects like shown in figures 9, 10). Some results of this project work were used in research projects of our university of applied science (without a figure) and a few of project results become real usable products (e.g. projects shown in figures 11-13).

Figure 13.
High speed power bank for mobiles.

Often especially such students, which do not have the best success in classical courses, excel by trying to get optimal project results. They are highly motivated from the beginning to the end of the project laboratories or they become highly motivated during the courses because of the direct feedback, the practical success, the appreciation of the team and the teaching staff. Figure 14 indicates an overview of topics.

Figure 14.
Classification of topics.



Classification	Topic Selection (small incomplete excerpt)
Inclusion and Access	E-book-reader with Braille Letter; Educational Robots for implementation in Brazil; Make colour hearable (colour to sound transfer); Elektromyogram to control computers;
Water Management	Transboundary Water Management in Africa through the establishment of dialogue platforms; Automatic Water Management System Purification of water in crisis regions or in civil protection;
Energy	Problems of Energy Generation (CSP-Concentrated solar power plant);
Technology, others	GoPro-action-cam-gimbal project for manual use in helicopters; Additional bike displays Wind hamster: high speed power bank for mobiles
Quality of Life	App for Windows Mobile which provides driving information of a motorcycle

4.5. New forms of external presentation

Another idea of the Project Laboratory course was that the students should present their projects to the public, for example during the open day at the university or on events in schools. Besides the presentation exercises for the students, it is a good possibility and opportunity to increase attractiveness and visibility of scientific and technical studies. The solutions were presented on several occasions, like Open-Day Events, Long Night of Sciences, especially in direct dialog with citizens (Fair of Bridge-Builders at Berlin Alexanderplatz, see figure 15).

Figure 15.
The Bridge Builder.

Berlin Alexanderplatz Kenako Fair: The Bridge-Builder.
Participant of the HTW ProLab presenting his concept about vertical farming.

Project Presentation *Berlin Kenako Fair*
Pictures by courtesy of Paul Knopf

5. FUTURE RESEARCH DIRECTIONS

In the further development of the courses, the aim will be an extension and adaptation of the concept to other fields of study and research areas. Within the framework of the so called ‘digital forest’ Department I of HTW Berlin which aims to establish a continuous exchange of ideas on different topics. Other forms of knowledge transfer (Hackathon Global Health) are planned with the Universidad Politécnica de Madrid (Spain), and in the energy sciences field, there are various interests in cooperating in the field of water management (Cameroun) or also education roboter (Brazil) and diversity studies (Namibia) with different intercontinental partners. Extending the concept will – with the accompanying research on the effect for students and teaching staff – provide answers to questions that have arisen from the first experiences (Bailleu et al., 2015).

Research-orientation in the courses ProLab and R&DLab may mean very different approaches depending on the field and discipline. This has immediate consequences for the organizers of the research process within the courses.

HTW Berlin has to react to diverse target groups within the student body, taking into account their different experiences with team working in a foreign language, working autonomously and producing results – i.e. presentations and publications, mostly investing additional time that required by their study program. Making use of electronical tools, and providing digital media for a multinational and in many senses 'blended' laboratory will be just one aspect of the further development, which can in the coming years to become one of the hallmarks of teaching.

6. CONCLUSION/DISCUSSION

The learning environment, which is designed without regarding the context of the learners does not touch the participants to any deeper level, and this curbs their ability to learn from the designed environment. In conclusion, the presented teaching method seems to have more advantages. A lot of students prefer to do some practical work during their studies. In most of the cases, they are very involved in their own projects. The learning process takes nearly by the way because it is a kind of learning by doing.

The presented new forms of learning combine research-based learning with international cooperation, and thereby they can motivate bachelor and master students to conduct research and to be engaged in academic discussion and in international frameworks. The courses increase the awareness of different research traditions and subject specialisations, and it sharpens the perception of different cultures of learning. The courses are purposefully designed around a suite to different digital communication tools, as digital storytelling. We regard this as a vital prerequisite for sustainable collaborations in the context of research-driven learning. Flexibility, openness and willingness to adopt different methods are essential in order to adjust the concept to different fields of research and teaching.

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