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Universities of Tomorrow: Global, Interdisciplinary, Digitized, Sustainable (UNITO)

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virtual event

This publication appears on the occasion of the international conference „Universities of Tomorow: Global, Interdisciplinary, Digitized, Sustainable (UNITO)“ on November 4th, 2021, online.

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PREFACE

The complex social, economic, and environmental issues of today and the rise of digital technology pose new challenges to societies and enterprises worldwide - and thus to universities as well. They need to respond to these developments today by educating and training the experts, specialists, and leaders of tomorrow. Additionally, the underlying long-lasting trends - globalization, interdisciplinarity, digitalization, sustainability - have been fuelled and accelerated by the COVID-19 pandemic.

Challenging times call for innovative measures and new approaches to teaching, research, and international collaboration to reshape the landscapes of higher education. In this context, the HTWG Konstanz invited our partners to UNITO 2021 to address the following questions in particular:

- What are the critical skills and areas of competence for tomorrow and how can we teach them most appropriately?
- How can a higher education system unleash the full potential of its learners?
- How can we meet the global challenges such as sustainability and digitalization as institutions of higher education?
- Where and how can we build alliances across and beyond universities?
- How can we sustain and strengthen university partnerships and collaborative efforts in times of climate change and limited mobility?

Authors and participants from all over the world and across all academic disciplines and stakeholders followed this invitation, met online on November 4th, 2021 and presented, discussed, and shared ideas, concepts, experiences, and best practices for the future. Three distinguished keynote speakers further enriched the conference and stimulated the discussion.

In the name of the whole organizing committee, I thank all these contributors who turned the conference into a most exciting and inspiring event.

Prof. Dr. Thomas Birkhölzer,

Conference Chair and Vice President HTWG Konstanz

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TRANSNATIONAL HIGHER EDUCATION FOR SUSTAINABLE DEVELOPMENT — TAKE NAN-JING INSTITUTE OF TECHNOLOGY, CHINA, AS AN EXAMPLE

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Abstract. *Since the establishment of diplomatic relations between China and Finland 70 years ago, the cooperation between the two countries in the field of education has been deepening, and the education for sustainable development (SD) between the two countries based on global responsibility, resource sharing, and joint construction of mechanisms has been continuously deepened. In the context of education globalization, transnational higher education (TNHE) cooperation between China and Finland needs to establish a partnership for the implementation of education for SD. The Software Engineering double degree program jointly launched by Nanjing Institute of Technology (NJIT) in China and the University of Oulu (UO) in Finland has carried out useful practical explorations under the UNESCO 2030 Agenda and China's Belt and Road Initiative. In the past three years of cooperation, the program vision has been clarified and the cooperation framework has been established by the two universities. It is argued that curriculum reconstruction, teacher training, scientific and cultural exchanges, focus on innovation and entrepreneurship, emphasis on academic support are the key SD activities, which combine knowledge, skills, awareness of responsibility, and attitudes. The TNHE double degree program between NJIT and UO has initially paved an effective path of the TNHE for sustainable development.*

Keywords: sustainable development (SD), transnational higher education (TNHE), higher education for SD, education globalization

1 INTRODUCTION

Sustainable development (SD) can be regarded as an important theoretical support and practical guidance to break the barriers of development in the world today and to advance the evolution of human civilization. The UNESCO 2030 Agenda has made an important commitment to SD in the field of education, aiming to promote the dissemination and practical development of education for sustainable development [1][2]. In September and October 2013, during his visits to Central and Southeast Asian countries, Chinese President Xi Jinping successively proposed major initiatives to jointly build the "Silk Road Economic Belt" and the "21st Century Maritime Silk Road", which is generally referred to as the Belt and Road initiative afterward [3]. In the field of higher education, with the deepening of globalization, the individual development model of higher education institutions (HEIs) can no longer meet the needs of the development of human society. Therefore, it is necessary to establish a new type of cooperative relationship and establish a common value pursuit so that SD can be achieved by the educational cooperation and exchange among different HEIs under the UNESCO 2030 Agenda and China's Belt and Road Initiative.

China and Finland have maintained friendly cooperation for a long time. Since the establishment of diplomatic relations between China and Finland in 1950, the two countries have signed 41 bilateral agreements and documents. For example, in 1980, a cultural exchange cooperation plan was signed and since then, cultural exchanges between the two countries have flourished. In 2015, a memorandum of understanding on comprehensively strengthening cooperation in the field of education was signed and in 2016, a memorandum of understanding on mutual recognition of degrees was signed by the two ministries of education

[4]. In addition, the two countries have established a number of innovation centers in the field of scientific and technological cooperation and reached a cooperation framework agreement[4]. In 2017, Chinese president Xi Jinping visited Finland. The two countries issued the "Joint Statement of the People's Republic of China and the Republic of Finland on Establishing and Promoting a New Type of Future-oriented Cooperative Partnership" [4], which promotes the educational cooperation to build a universally compatible and symbiotic education system for SD.

The transnational higher education (TNHE) between China and Finland is one important part of the future-oriented cooperative partnership. There are currently nine Sino-Finnish TNHE institutions and programs being carried out in China [5]. The Software Engineering undergraduate double degree program jointly launched by Nanjing Institute of Technology (NJIT) in China and the University of Oulu (UO) in Finland is one of them. Since its implementation in 2018, the program has carried out useful practical explorations under the UNESCO 2030 Agenda and China's Belt and Road Initiative to strive for SD.

2 TNHE DOUBLE DEGREE PROGRAM BETWEEN NJIT AND UO

The Nanjing Institute of Technology (NJIT) is located in Nanjing, a famous historical and cultural city in Jiangsu Province, China. It is the chairman unit of the National Special Committee of Application-oriented undergraduate universities, the vice-chairman unit of the National Service Special Needs Master Graduate Cultivating Unit Alliance, and the first batch of pilot universities to implement "Excellent Engineer of the Ministry of Education' Training Plan" and "CDIO Engineering Education Reform". It has a hundred years of history and now NJIT has become an engineering-based university, with disciplines covering engineering, economics, management, literature, law, art, etc. [6]. The University of Oulu (UO), founded in 1958, is one of the biggest and the most multidisciplinary universities in Finland. It conducts impactful and responsible research and the aim is to provide an excellent student experience and a healthy university community [7]. The two universities have a common vision, that is, to provide the best education for the students and to serve the local economic and societal development.

NJIT has been doing substantive cooperation with UO for 5 years, in the aspects of students and teachers exchange, cooperation in scientific research, and introduction of high-end talents, etc. In 2016, the two universities started to apply to the Ministry of Education (MOE) of China for jointly running a double degree TNHE program in Software Engineering. In July 2017, the program was approved by the MOE of China and began to recruit students in 2018. It adopts the "4+0" model, which means Chinese students study for 4 years at NJIT without crossing board to Finland. After completion of all the courses, they can get bachelor's degrees from both NJIT and UO. The enrollment of students in 2018 was 93 and at present, there are 4 sessions with 376 students in the program.

3 EDUCATIONAL PRACTICES OF TNHE DOUBLE DEGREE PROGRAM

3.1 OBJECTIVE AND RECONSTRUCTION OF CURRICULUM

The focus of the cooperation between NJIT and UO is to introduce and integrate UO's advanced educational concepts, teaching methods, and high-quality intellectual resources to continuously improve the internationalization and education quality of NJIT. The ultimate goal of the program is to cultivate more talents with professional skills and cross-cultural communicative skills that can adapt to the ever-changing society and economy, and can work in the Finnish-invested enterprises in China.

NJIT and Oulu jointly design the curriculum firstly, including quality control standards and course quality assessment criteria, which are regarded as the essential elements of the program. In the curriculum, 19 core courses on Software Engineering come from UO and are taught by UO teachers, which accounts for 92.3% of all professional core courses. In 2018 and 2019, UO teachers traveled to China to teach the courses and in the recent two years, they teach online distantly because of the pandemic. NJIT assigns 1or 2 local teachers to assist UO teachers in their teaching, which is considered a very important part of teaching because of

the cultural differences. During the pandemic, this "dual-teacher teaching model" seems more important in that local teachers can teach face to face in China so that it can lessen the weaknesses of online distant teaching.

3.2 TRAINING OF TEACHERS

The training of teachers is especially important in TNHE programs. The cultural differences in the two countries will lead to the differences in the educational field, such as in-class teaching methods, ways of communication, evaluation process, etc. The first and foremost training is the understanding of both cultures. UO teachers need to understand Chinese educational backgrounds and Chinese students. NJIT teachers need to understand UO teachers' way of thinking and teaching methods. And Chinese students need to be adjusted to the way of UO teachers' teaching. NJIT sends 4 local teachers to UO every year to learn the teaching models of UO teachers and prepare the following teaching documents together with UO teachers (which stops because of the pandemic during the recent two years). UO teachers organize workshops to share the understanding and experience of teaching Chinese students. All these help to improve the quality of program teaching.

3.3 SCIENTIFIC AND CULTURAL EXCHANGES

The scientific and cultural exchanges between the two universities are undertaken based on the program now. The "NJIT-UO Joint Research Center" and "Sino-Finnish Cultural and Communication Research Center" were established in 2019 and 2020 respectively. In 2019, two scientific research projects co-hosted by the NJIT and UO professors were approved as "Selected Projects for the First Batch of Joint Scientific Research Projects of Sino-foreign Cooperation in Running Schools in Jiangsu Province". One of them is called "Sino-Finnish Energy and Environmental Technology Joint Research and Development", whose Finnish partner is the famous air purification equipment supplier: Genano Air Purification Equipment Company.

Shanghai Office of the Finnish National Education Agency gives much support to the program. Students in the program take part in the different activities organized by it such as "Sino-Finnish Workplace Exchange Night" and "Future: Created in Finland" etc., which have broadened students' international horizons, enhance students' career positioning, and deepen students' understanding of Finnish society, culture, and humanities. In June 2021, an international conference on Transformation on Business and Education was jointly organized by NJIT and UO.

3.4 FOCUS ON INNOVATION AND ENTREPRENEURSHIP

So far, based on the program, NJIT teachers have got 2 national patents, published 8 high-level SCI or SSCI papers, and got 1 National Natural Science Foundation project. The scientific research projects are also associated with the innovation and entrepreneurship of students. Based on the platform of scientific researches, NJIT and UO teachers, together with enterprise engineers, jointly supervise students to participate in more than 30 provincial and university-level science and technology innovation and entrepreneurship projects. 12 academic papers were published by students, including 3 SCI papers and 2 EI papers.

The program also provides international human resources for Chinese and foreign enterprises and provides a sharing platform for the markets, products, and R&D technologies. For example, Finland's largest software engineering research institute M3S, and Nanjing Iveco Automobile Co., Ltds., contacted and got into the research partnership. The program students participated in the Finnish corporate exchange activities organized by the Shanghai Office of the Finnish National Education Agency, which gave students opportunities to have a close link with the vital interests of enterprises and some of them have done an internship in these Finnish enterprises in China.

3.5 EMPHASIS ON ACADEMIC SUPPORT

The students in the program face big challenges. On the one hand, all the courses that UO teachers teach are in English. On the other hand, they are not accustomed to the way UO teachers teach because it is so different from what they were taught in their high school. Academic support should be given to students. The "Academic Planning and Guidance Center" is established to help them learn better in their studies. Through professional frontier lectures, scientific innovation lectures, academic lectures, English competitions, and other activities, a strong learning atmosphere is created and during the activities, students not only improve their academic standards but also strengthen their overall qualities and abilities.

4 CONCLUSIONS

During the 3 years' development, the TNHE program between NJIT and UO has made great improvements in teaching, scientific research, students' cultivation, etc., laying a sound foundation for the establishment of "Nanjing Institute of Technology - University of Oulu School". In October 2018, witnessed by the Minister of Education and Culture of Finland and the Finnish Ambassador to China, NJIT and UO signed a memorandum of cooperation for the establishment of the NJIT-Oulu School, and in December 2019 two presidents agreed to jointly apply for the NJIT-Oulu School to the MOE of China. Now the application work has been finished and is waiting for the evaluation from the MOE of China. The proposed NJIT-Oulu School includes four programs: software engineering, information system and management, civil engineering, and environmental engineering. It will be a sustainability-oriented school that focuses on sustainable development technology, carbon peaking, and carbon neutrality technology.

During the cooperation, NJIT and UO take the concept of higher education for SD as the guidance. They set a common goal, share common resources, and take global responsibilities. The cooperation framework that they establish can be a model for other universities worldwide in the TNHE for sustainable development.

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HOW TO USE THE NEW GENERATION OF INFORMATION TECHNOLOGY TO ENHANCE INTERNATIONAL COOPERATION OF EDUCATION AND RESEARCH BETWEEN CHINA AND GERMANY UNDER THE EPIDEMIC

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Abstract. *China and Germany are important strategic partners in education. Both countries have intensified their cooperation in recent decades to increase their innovative strength. The Chinesisch-Deutsche Technische Fakultät (CDTF) which is established and approved by the Chinese Ministry of Education as a higher education cooperation project incorporated into the framework of the Sino-German Intergovernmental Education Cooperation Program in 2001. This article introduces the cooperation between Chinese and German teachers and students on both teaching lectures and scientific research projects performed on the CDTF platform under the impact of the epidemic. The application of the next generation of information technologies such as digitalization, networking, and intelligence on the CDTF platform to build smart classrooms and smart laboratories through VR and digital twinning, which broken the restrictions of geographical and time domain, met the demand for sharing of quality education and research resources between China and Germany and intensified the Sino-German cooperation.*

Keywords: CDTF, Cooperative Education, Interdisciplinary, Digitized, Smart Teaching

1 INTRODUCTION

International cooperative education has always been one of the research topics in the academic field. Germany and China have established a long-term strategic partnership, both countries have close cooperation in research and education with nearly 1,400 cooperation agreements signed between their partner institutions [1]. With the development of cooperation between the two countries in the fields of education, science, and research, more research institutions and scientific research organizations have been established in China [2], which has strengthened the presence of German research in China, thereby helping to further expand the cooperative relationship with China [3].

The Chinesisch-Deutsche Technische Fakultät (CDTF) was officially established under this background in 2001. The faculty is approved by the Chinese Ministry of Education as a higher education cooperation project incorporated into the framework of the Sino-German Intergovernmental Education Cooperation Programme. Meanwhile, it is part of the German Government's “Investing in the Future Programme” (ZIP) and is funded by the BMBF and DAAD. The faculty offers now different joint education programmes with several German universities at bachelor’s, master’s, and doctoral levels. More than 1,500 students from the CDTF studied in Germany till now, including more than 30 current and graduated PhDs.

The purpose of the faculty is to cultivate world-class talents with the fusion of the essence of eastern and western cultures. The positioning of the faculty is to play the role of a base for international talent training and an innovation platform led by Chinese/German technology. At the same time, the faculty should be a bridge and a window for Chinese-German cooperation and exchange with the objective to train engineering and management-oriented talents with Chinese and German cultural backgrounds and language skills.

To achieve the objective, a German language center was built beside our scientific staff team. More than one-third of the teachers are from Germany so that the students may learn the original German language

which is very important for their future study in the German university. The scientific team of the faculty is composed of senior professors from German universities and outstanding teachers such as Taishan scholars from Qingdao University of Science and Technology. There are 56 Chinese employees in the faculty in Laoshan Qingdao, most of them have doctor titles and some of them are graduated from German universities.

The faculty has 24 small classrooms, 2 technical centers in the areas of intelligent manufacture and industrial internet. In addition, there are laboratories that cover the areas of 3D printing, process control technology, measurement and control technology, and chemical technology with a total area of more than 2,000 square meters.

The development of the faculty has led to exchanges between Qingdao and the German city of Paderborn. It has also served as a bridge and link for economic, trade, scientific, and cultural exchanges and cooperation between Qingdao and other German cities like Wernigerode, Regensburg and Ingolstadt, and so on. Because of his contribution to international cooperation, one of our founders of this faculty, Prof. Pahl of the University of Paderborn, and his colleague Prof. Fels have been awarded the "Qilu Friendship Award of Shandong Province". The president of the University of Paderborn, Prof. Riegraf has been honoured the title of "People's Friendship Envoy of Shandong Province".

In terms of faculty characteristics and discipline construction, the “two-pillar” educating model is implemented. The training programme focusing on the cultivation of students' intercultural communication skills, engineering practice, innovation and entrepreneurship, international awareness, and international employment competitiveness is jointly developed by Chinese and German universities. To combine the education resources both in China and Germany, the course of German language is taught by the cooperation of Chinese and German teachers in small classes. The teaching of professional courses is taught in pairs by Chinese and German professors.

In addition to exchange visits between professors, exchanges between students are also taking place at the same time. Nearly 100 students have been sponsored by DAAD to attend summer training courses in Germany, and about 60 students have come to China for their master's thesis. The exchange of students between the two countries has effectively promoted the integration of cultures and ideas. Till now more than 1500 students have gone to Germany for further study and more than 80% of the graduated students from the faculty continue to study for master degrees at the elite German universities. The previous outstanding graduates have received more than 600,000 euros from DAAD scholarships.

Since the establishment of the faculty, it has cooperated and built a successful relationship with the industry both in China and Germany, such as Siemens, Mercedes-Benz, BMW, Volkswagen, Phoenix Contact, BASF Co., Ltd., China Power Media Group, China Academy of Railway Sciences, Qingdao Andre Steel Power Tools Co., Ltd., etc. Many outstanding graduates have been awarded various types of scholarships, some of them have been employed by different German and Chinese companies.

2 CHALLENGES UNDER COVID-19

The outbreak of the COVID-19 epidemic has not only caused a huge impact on public health, economic and social fields [4], but also brought severe challenges to international cooperation, especially to international cooperative education.

2.1 CHALLENGES FOR FOREIGN TEACHERS COMING TO CHINA

As a result of the epidemic, the teaching of foreign teachers in China has been affected by a number of domestic and international policies. The key challenges include international travel restrictions, increased risk of outbreaks, and isolation requirements.

The international travel restrictions such as entry and exit restrictions, vaccinations, etc., have caused a reduction of the number of flights between China and Germany and increased the travel costs of foreign teachers. The exchange of teachers may also increase the risk of an outbreak, as well as many potential risks of epidemics. Local disease control departments and universities need to increase investment in infection prevention and control costs. Furthermore, entry personnel needs to be quarantined to comply with the country's epidemic prevention regulations, which is also not conducive to the teaching arrangements of the faculty.

2.2 CHALLENGES FOR STUDENTS TO STUDY IN GERMANY

As the epidemic has never been effectively controlled, the students have to face a range of problems such as entry and exit restrictions, vaccinations, physical and mental health when studying in Germany, as well as a series of challenges, mainly including the still critical epidemic situation, the more complex management of students abroad and higher entry and exit costs.

The feasibility and necessity for the students to study in Germany are challenged due to the severe epidemic situation. The enthusiasm of students and parents to study in Germany has also decreased. Not only that, but the management of students abroad is also becoming more and more complicated. The faculty needs to pay more attention to the living conditions, learning conditions of the students abroad. In addition, the cost of entry and exit fees for students has increased because of the vaccination requirements for entry and exit, visa requirements, and other complicate procedures. The cost of flight expenses and isolation time becomes higher.

2.3 UNCERTAINTY FOR THE FACULTY

Under the influence of the epidemic, there is greater uncertainty in the management of the faculty, which poses challenges for the smooth running of teaching, learning, and researching.

The teaching must be well organized because the flights (economic costs) and isolation measures (time costs) will remain in place for a long time. If the students could not go to Germany with the impacts of travels restrictions, they must reorganize their studies in China. A better solution must also be found to continue the cooperation on the research.

3 APPLICATION OF INFORMATION TECHNOLOGY IN COOPERATIVE EDUCATION

The CDTF is a platform for teachers and students from China and Germany to cooperate and collaborate on both teaching lectures and research projects. The platform is strongly based on personal exchanges and communications. These exchanging activities are also impeded through the unprecedented global health crisis since the year 2020. In order to get through this difficult period smoothly, the new information technology has been applied in cooperative education at the university in Qingdao.

3.1 REMOTE TEACHING OF THEORY COURSES

Under the influence of the epidemic, some foreign teachers are unable to come to China to conduct their teaching as scheduled. In order to ensure the smooth running of the teaching programme, the faculty has planned the construction of a smart classroom. So that the German teachers, who bring in teaching resources from the German side through the internet, can work together with the Chinese teaching assistants to complete the teaching tasks.

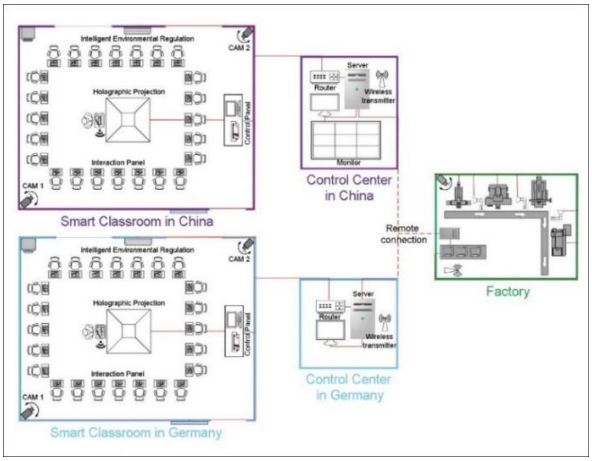

Figure 1: Framework of the Smart Classroom

As shown in Fig.1, the smart classrooms with control centers are set up both in China and Germany, which are connected through the high-speed network. The remote connection can also be built between the factory and the classrooms if necessary to provide the students with a view of the process. During the teaching process, teachers and students can discuss and interact with each other across countries. The smart classroom can utilize multi-dimensional video/audio capture and a high-speed network to achieve real-time teaching and communication between teachers and students.

3.2 REMOTE GUIDANCE OF EXPERIMENTAL COURSES

Another solution is building a new smart lab and upgrading the lab instruments so that the faculty can provide German teachers and corporate tutors the possibility to give remote guidance in an experimental course. With video monitoring of each experimental group and data collection from each experimental process, the teachers can also interact with the students during the experiment.

3.3 VIRTUAL SIMULATION PROJECTS IN SMART TEACHING

The virtual simulation is also applied to smart teaching at the Qingdao University of Science and Technology. Two high-level teaching platforms including national-level chemical process and equipment experimental teaching center and chemistry experimental teaching center were established with virtual simulation technology. Different virtual simulation experiment projects such as experimental simulation of electrochemical corrosion and protection in the ocean, 3D virtual simulation comprehensive experiment of catalytic cracking absorption unit, etc. are being carried out. The virtual simulation experiments resources mainly include comprehensive experiment, unit operation, large instrument operation, process, safety, and emergency.

3.4 REMOTE EXPERIMENTAL COURSES AT QUST

Till now, 9 online experimental courses, 12 virtual simulation experimental courses, 41 virtual simulation experimental teaching modules with more than 160 experimental projects, which cover information technology, mechanical engineering, chemical industry, chemistry, material science, environmental engineering, energy sources, media, sports, and other disciplines. Nearly 60000 students have enrolled in the courses accumulatively.

4 OUTLOOK AND FURTHER STEPS

With the continuous development of the globalization process, the importance of higher education cooperation is increasingly manifested in the development of the China-EU partnership [5]. German and Chinese researchers can work together to find innovative solutions to global challenges and lay the foundation for

our future prosperity [6]. As a further step, advanced training and expert guidance are considered to help the teachers and students understand and learn smart teaching better. To optimise and standardise smart teaching, questionnaires, research and analysis, online supervision and quality control will also be performed. The teaching competitions can be held to test and enhance smart teaching.

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DIGI EDU: DIGITALIZATION OF EDUCATION IN THE FACULTY OF SOCIAL SCIENCES AND HUMANITIES, UNIVERSITI TEKNOLOGI MALAYSIA THROUGH 'EDUCATING' AND 'HUMANIZING'

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Abstract. *With the advent of Industrial Revolution 4.0 (4IR) and Education 4.0, the need to digitize education has become ever more pressing for Higher Education Institutions (HEI). Over the years, Universiti Teknologi Malaysia (UTM) has pursued an important mission to digitize education by leveraging on 4IR. It aims at uprising education and building a resilient eco-system to deliver a good quality education that is integrated with technology and data-driven technique. UTM has actually taken a large-scale initiative toward digitising education which began in 2013. To achieve this mission and vision, the Faculty of Social Sciences and Humanities (FSSH), UTM has been the evangelist in pioneering the effort to digitise education through the "Educating and Humanizing Program" to accustom academic staff to the use of Online Learning (OL) in their teaching and learning. In this regard, we have initiated a project named "DIGI EDU" which consists of three focus areas: a) Online learning and teaching, b) Stress, emotion, and spiritual management, and c) Sustainability during the COVID-19 pandemic. The main objectives of "DIGI EDU" are to strengthen and enculture the digital learning and teaching initiatives during the COVID-19 pandemic, to balance and harmonize emotional, wellbeing, and spiritual management among staff and students during the COVID-19 pandemic, and to promote sustainability and knowledge transfer to the stakeholders and the society. Three types of audiences were involved in the implementation of "DIGI EDU", such as (i) academicians including lecturers from public and private universities, polytechnic lecturers and school teachers across Malaysia, (ii) non-academicians including support staff, parents and community members, and (iii) students including undergraduate students, postgraduate students, online distance learning students and higher institution students who study at polytechnics, community colleges, and teacher training institutes. DIGI EDU has a variety of project implementation processes and techniques, which are Blended and Online Learning Taskforce, Alternative Assessment Taskforce, e-rubric System (FSSH Rubric-GEN 2.0), Online Interview, Empowering Future-Ready Educator, and Implementation of OMELET (Online Learning and Teaching Content) platform. Besides that, we also initiated the empowerment of future-proof talents through educating and humanizing people in this DIGI EDU Program. This is encapsulated in the initiative of FSSHeart (i.e. Happy, Empathy, Appreciate, Responsible, Trust) with the aims to strike a balance between the digital learning initiatives and the staffs' and students' stress management during the pandemic.*

Keywords: Universities of Tomorrow, Digital Education, Sustainability

1 INTRODUCTION

With the advent of Industrial Revolution 4.0 and Education 4.0, the need to digitize education has been ever more pressing for Higher Education Institutions (HEI). Over the years, Universiti Teknologi Malaysia (UTM) has pursued an important mission to digitize education by leveraging on 4IR. It aims at uprising education and building a resilient eco-system to deliver a good quality education that is integrated with technology and data-driven technique. UTM has actually taken a large-scale initiative toward digitising education which began in 2013. In enhancing the implementation of online learning, UTM glorifies the best practices through NALI (New Academia Learning Innovation). Moreover, following the National e-Learning Policy (DePAN), for Phase 3 (2021-2025), 70% of all courses offered by each IPT are required conducted in the form of blended learning (Blended Learning). In addition, 15% of e-Assessment needs to be implemented in blended learning.

2 MISSION AND VISION OF DIGI EDU

To achieve this mission and vision, the Faculty of Social Sciences and Humanities (FSSH), UTM has been the evangelists in pioneering the effort to digitise education through educating and humanizing to accustom its staff towards the use of OL in their teaching and learning. The vision is 'Digitization of Education: DIGI EDU' and the goals are by educating and humanizing FSSH. FSSH DIGI EDU objectives are:

a) to initiate, strengthen and cultivate digital L & T during the unprecedented event like COVID19
b) to develop equilibrium of emotional, wellbeing and spiritual among staff and students during the pandemic
c) to promote sustainability and knowledge transfer to the stakeholders and society

3 DIGI EDU INITIATIVES

Through DIGI EDU, we initiate the empowerment of future-proof talent, through Educating and Humanizing, and this is encapsulated via the FSSHeart initiative (Happy, Empathy, Appreciate, Responsible, Trust). The DIGI EDU initiative is encompassed upon seven criteria: UTM Mission and Vision, Stakeholder involvement, Planning, Implementation, Coordination, Performance Measurement, and Sustainability.

3.1 STAKEHOLDER INVOLVEMENT

We divided the stakeholder involvement into two categories which are contributors and audiences. Three types of audiences were involved in the implementation of "DIGI EDU", such as (i) academicians including lecturers from public and private universities, polytechnic lecturers and school teachers across Malaysia, (ii) non-academicians including support staff, parents and community members, and (iii) students including undergraduate students, postgraduate students, online distance learning students and higher institution students who study at polytechnics, community colleges, and teacher training institutes.

3.2 PLANNING AND IMPLEMENTATION OF THE DIGI EDU

Six initiatives were established in DIGI EDU. Figure 1 shows the implementation of DIGI EDU initiatives.

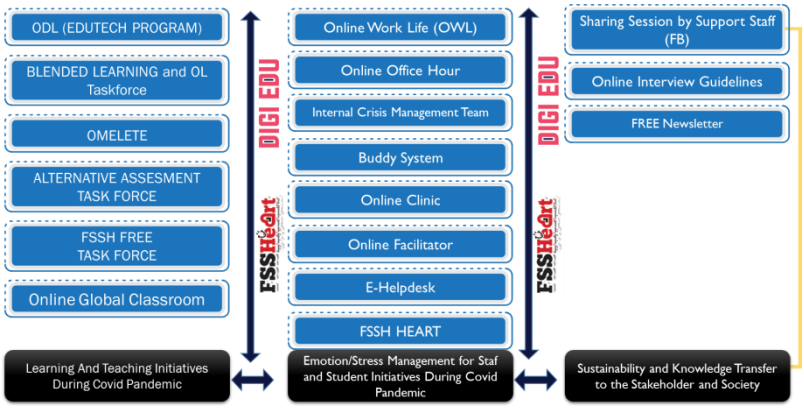

Figure 1: The implementation of DIGI EDU initiatives.

The DIGI EDU initiatives are:

Blended and Online Learning

The initial phase started in March 2020, followed by the launching of the Buddy System and programs such as Online Work-Life and Online Learning talk. The report on FSSH UTM's Experience Towards Digitization Education [1] was published in 2 books.

Alternative Assessment

The initial stage commenced in March 2020, followed by a series of workshops and briefings. Between Aug to Sept 2020, a copyright application is initiated. Between Nov to Dec 2020, briefings on preparation on Online and Take-Home Exams [2] were conducted.

e-Rubric System

The e-Rubric system was commenced in Jan 2020, a series of workshops on the development was conducted. Between October to November 2020, the system was developed and designed. In December 2020, the test run of the rubric and system amendment.

Online Interview for School of Education undergraduate program

The online Interview was initiated in March 2020. The following months were the development stage of the system. By July, a test run was staged. In August, a copyright application was put forward and finally, a book about the online Interview Guideline [3] was produced as evidence of the initiative.

Empowering Future-Ready Educator

DIGI EDU Project was activating the programs towards Empowering FREE@FSSH.In March 2020, the appointment of Committee members was done and followed by planning for training and implementation. By June 2020, surveys were conducted. Between August to Nov 2020, meetings were held and sub-group leaders were appointed. The group leaders took the helm and conduct activities for their groups. From July to Nov 2020, a series of briefings were conducted to strengthen the understanding. For documentation purposes, a FREE Newsletter was published in Dec 2020 [4].

OMELET (Online Material for Learning and Teaching)

OMELET is initiating a repository system, that conceptualized lecturers and students as content curators for their own Learning &Teaching materials [5]. It is aimed as a one-stop information centre for FSSH teaching and learning sources and innovative pedagogies. In the longer run, the system has the advantages as an alternative platform for providing low technology development of learning material while archiving FSSH T&L sources.

3.3 CONTROL AND COORDINATION

The Implementation process is being controlled and coordinated by the FSSH Dean and task forces/committees. Under the DIGI EDU Educating goal, it was led by the Deputy Dean of Academics. For Humanizing goal, it was led by Deputy Registrar. The Monitoring process of those initiatives was done by a Faculty management member led by the FSSH Dean.

3.4 PERFORMANCE MEASUREMENT

The processes are being reviewed and evaluated accordingly. Figure 2 shows the performance measurement of the initiates in DIGI EDU. The evidence is presented through reports and statistics on online learning; Online Alternative Assessment and SocMed Analytic. OMELET is a FSSH high-impact project, that serves as a one-stop e-repository platform. In total, 181 numbers of Learning & Teaching materials had been submitted to OMELET during the COVID19 outbreak. In order to maintain the quality of Learning & Teaching during COVID19, two modes of the online method are practised, namely the Synchronous and Asynchronous Online Learning. The result shows that the highest Synchronous Online Learning is via the School of Education (42.83%) and the highest Asynchronous OL is initiated by Language Academy (33.86%). A survey on students' knowledge, readiness, and preparedness level during MCO had been conducted. The results are 42% of students are high in knowledge to utilize existing tools for online learning while 31.4% of students are moderately ready for online learning and 37.8% of students are moderately prepared to perform an online assessment [1].

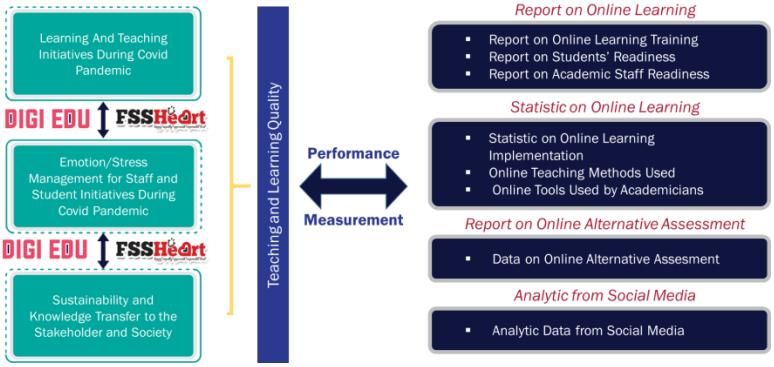

Figure 2: Performance Measurement of DIGI EDU

FSSH also implemented the Online Alternative Assessment for both postgraduates and undergraduates during the Movement Control Order (MCO). The implementation includes substituting final exams with assignments and projects; alternative take-home final exams and conducting online final exams. In total, 116 alternative assessments had been performed during MCO. Blended Learning enables FSSH UTM academic programs to be more accessible and marketable by promoting the practice of using both online and in-person learning experiences, for example, Open Distance Learning (ODL). The plan began in October 2019 and COVID-19 accelerates the online learning process. Seven workshops on Future Ready Educator (FREE) empowerment were conducted and received satisfactorily numbers of staff participation [4]. In order to improve the implementation of FREE during the pandemic, some findings were suggested [1] as follows :

a) Work From Home limits F2F interaction, thus online meeting is recommended

b) a Project-based Learning (PjBL) approach was initiated to replace suitable projects

c) students learned to work in remote team-working

d) a yearly planner is provided for PBL groups' activities

e) Problem Based Learning newbies are encouraged to implement the methods in any of their courses

f) fieldworks are on a smaller scale and didn't involve costs and sponsorship

Participants' mindset, knowledge, and motivation are more responsive towards the use of technology after the online clinic [1]. During MCO, 99.5% of overall Undergraduate and Postgraduate courses had been successfully conducted via OL in FSSH. To further analyse the success of the FSSH OL initiative, analytic data had been performed. YouTube indicates a 904.6K minutes were spent on viewing. Social Media analytic data indicates that FSSH's page has received a number of 56% female followers and 43% of male followers. FSSH produced and published documented guidelines and webpages as evidence of sustaining the FSSH Learning & Teaching Project initiatives under the Alternative Assessment, FREE, OMELET, Online Distance Learning, Online Learning, and Blended Learning.

3.5 SUSTAINABILITY

Driven by Continuously Quality Improvement (CQI), the planning, initiation, review, and implementation of DIGI EDU initiatives are outlined clearly using the Plan, Do, Check, and Act (PDCA) cycle as shown in Figure 3.

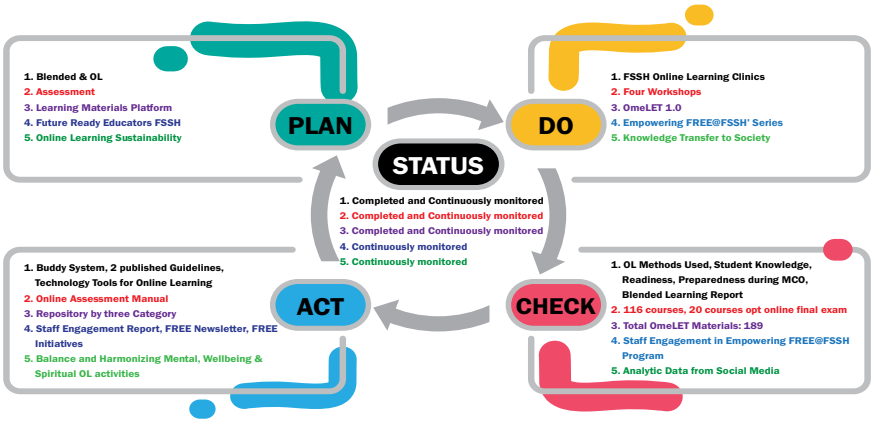

Figure 3: Course Quality Improvement and PDCA of DIGI EDU

The most significant part of the CQI is that:

a) how we monitored the initiatives

b) how the Plan, Do, Check and Act the project and initiatives during the Covid pandemic

c) and finally, how we ensure that the project and initiatives would contribute and sustain the quality of Learning and Teaching during the Covid pandemic at FSSH.

4 CONCLUSION

DIGI EDU has a variety of project implementation processes and techniques, which are Blended and Online Learning Taskforce, Alternative Assessment Taskforce, e-rubric System, Online Interview, Empowering Future-Ready Educator, and Implementation of OMELET (Online Learning and Teaching Content) platform. Besides that, we also initiated the empowerment of future-proof talents through educating and humanizing people in this DIGI EDU Program. This is encapsulated in the initiative of FSSHeart (i.e. Happy, Empathy, Appreciate, Responsible, Trust) with the aims to strike a balance between the digital learning initiatives and the staffs' and students' stress management during the pandemic.

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INDUSTRY – UNIVERSITY COOPERATION IN THE RENEWABLE ENERGY FIELD IN SOUTH AFRICA – GAP ANALYSIS AND ENHANCEMENT PROPOSALS

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Abstract. *The four megatrends – globalization, interdisciplinarity, digitalization, and sustainability – are fully addressed by the EURYDICE project funded by the Erasmus + program. Within this project, the focus is on renewable energies to support the energy system transition to a sustainable one in South Africa. The energy generation landscape in South Africa is undergoing a fundamental transition, as the vision of the energy strategy is to contribute to affordable energy for all. This vision will be supported by the project. This paper presents the first results from the project, which includes "open lab" and "mobile labs", a learning management system, and the Fast-track Acceleration Programme based on a gap analysis.*

Keywords: Universities of Tomorrow, Global, Interdisciplinary, Digitized, Sustainable, Industry cooperation, Applied Sciences

1 INTRODUCTION

As this transition is a global challenge, the South African high education institution (HEI) can profit from experiences from the European HEI and add their "local" know-how. The initiative for the ERASMUS application derives from the project Danube Universities, which includes universities from countries along the Danube. All European partners in the EURYDICE project are partners in this Danube network. Hence the project not only contributes to the macro-regional strategy of the European Union for the Danube Region but also transfers know-how beyond the borders of the European Union. This alliance between universities and other stakeholders not only strengthens the cooperation between the project partners but is also a relevant contribution to numerous European strategies.

The overall goal of the project is to enhance the employability of graduates in the field [1]. Industry often complains that practical/applied experience of the graduates is missing and that it would take longer to bring the young starters "on track." This lack of practical experience with different impacted problems for all groups—students, universities, graduates, and industry—can be found on all the layers of the education system in South Africa: vocational training, diploma studies, bachelor and postgraduate studies.

Therefore, the project will close the gap between Technical and Vocational Education and Training Colleges studies and diploma studies by the definition of industrial experience requirements for University of Technology (UoT) diploma students. This leads to an increased preparedness and "studyability" of UoT diploma students. The project will develop an "Industrial Portal" to include the industry. To increase industry cooperation in postgraduate education, "Open Labs" and "Mobile Labs" will be developed. It is

intended that industry brings industrial problems into the “Labs”, which will then be solved by the students. To address digitalization, which is accelerated by the COVID crisis, these labs will be enabled to be accessed remotely. An acceleration program for the students of the South African HEI will be developed as well to enhance their entrepreneurial and interdisciplinary competencies.

To integrate the practical cooperation with industry and to enable the students tp get to real cases, at each HEI in South Africa an immobile “Open Lab” and “Mobile Lab” which reflects the special competence in one or more renewable energy topics will be designed. At each South African HEI, a “Mobile Lab” in a trailer size will be developed, with one or more special renewable topics. This enables the HEI to share special equipment while transporting the “Mobile Labs” from one to another location. It will also enable the HEI to have showcases in other education units e.g., in rural areas to attract young people and especially females to engage in technical studies and work in renewable energies.

The mobile labs have been defined in a manner that addresses the identified gaps at the respective HEI in South Africa as well as address the desired use-cases. The following aspects and requirements are briefly introduced.

2 MEASURES IMPLEMENTATIONS

The gap analysis which is based on a questionnaire answered by the three participating HEI in South Africa and general studies in South Africa ([2], [3], [4], [5], [6]) results in deficiencies in the university-industry-cooperation in all the different layers of the education system in South Africa. These deficiencies cannot be fully eliminated by the project but improvement can be achieved. The following three measures are the major examples of how the project addresses these issues**.**

2.1 DEVELOPMENT OF THE MOBILE LAB

The mobile lab is a challenging prospect, as all components will have to be installed in a cross-terrain trailer/unit. Integration between the existing trailer systems and proposed renewable power sources must be accomplished and IoT devices must monitor and report to the on-board PC within a LabVIEW platform. Figure 1 illustrates the concept with the proposed system ratings,

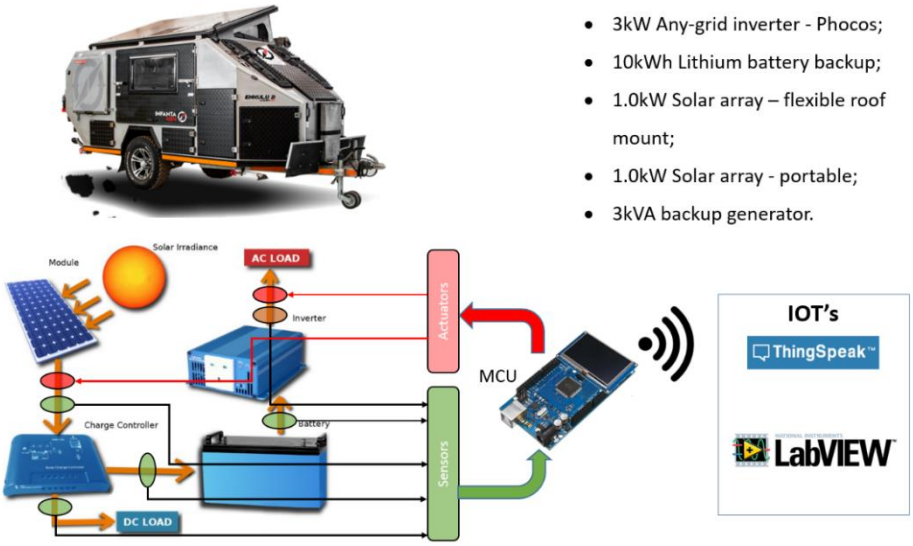

Figure 1: Concept of the cross-terrain trailer/unit

GPRS communication will facilitate remote access, location, and system performance operation.

A two-stage extension is foreseen as a

- Mobile lab extension I – PV System
- Mobile lab extension II- Small Wind turbine

2.2 DEVELOPMENT OF THE OPEN LABS

Defining the remote labs in a manner that addresses the identified GAPs and other use-cases, the following aspects and requirements are briefly introduced.

It is planned to have:

- One renewable "Off-Grid Lab" where students can do research on demanding off-grid systems as Solar-Home-Systems of Mini-Grid-Systems. The students learn based on real case studies e.g., how to design a mini-grid system for rural areas.
- One renewable "Smart-Grid Lab" where smart energy systems can be analyzed and developed. The students can learn based on the real case problem of power cuts, how a smart system can minimize or avoid power cuts.
- One "Renewable Energy Sources Lab" to analyze different renewable sources under different conditions. The students will learn how available technologies can be analyzed for application in SA. E.g., solar cells behavior strongly depends on environmental conditions as temperature, not all technologies are suitable for SA conditions. To keep the efficiency of a system, solar modules have to be cleaned from dust. Different technologies and methods will be analyzed.

2.3 DEVELOPMENT OF THE INDUSTRY PORTAL

EURYDICE LEARNING MANAGEMENT SYSTEM (ELMS) is a portal that will be developed and used as a working tool for industry, offering industrial placement to students, and for students, searching for industrial placements. The innovative "Industrial Portal" enables the industry/university cooperation to offer matched placements for the student's needs at different levels of education. But also, projects can be submitted into the portal by the industry for which students can apply and work . These projects could be used within the education itself but also for graduation work if the projects classify as such.

The framework description is as follows: ELMS is made up of four key components with data being sent between them. Figure 2 shows the complete ELMS framework with the four key components and the kind of data sent between them.

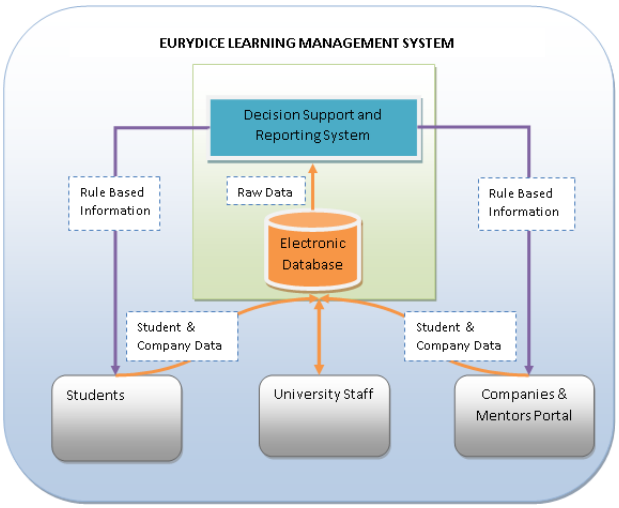

Figure 2: ELMS Framework

2.4 OFFERING TAILORED-MADE FAST-TRACK ACCELERATION PROGRAMS FOR GRADUATE STUDENTS

Complementary to the curriculum tailored-made Fast-track Acceleration Programs for graduate students will be offered within the project. These programs will build the capacity of the SA HEIs to support graduates in their aspirations to become successful entrepreneurs in the challenging energy industry and help prepare students for the corporate world through blending practical experience and operational challenges into standard economic and business lessons. The methodology that will be used to undertake this task combines open innovation, mentoring/ coaching, virtual incubation as well as "hands-on" work on actual solutions. It is well established that SMEs play a key role in creating employment, developing a skilled workforce, and responding to various market demands. This task will make efficient use of the business incubator model to demonstrate & facilitate the birth of small and medium enterprises (SMEs) in the renewable energy sector with innovative ideas and growth prospects. Figure 3 shows the aims of the Programme, the objectives, and the necessary steps of the Fast-track Acceleration Programme.

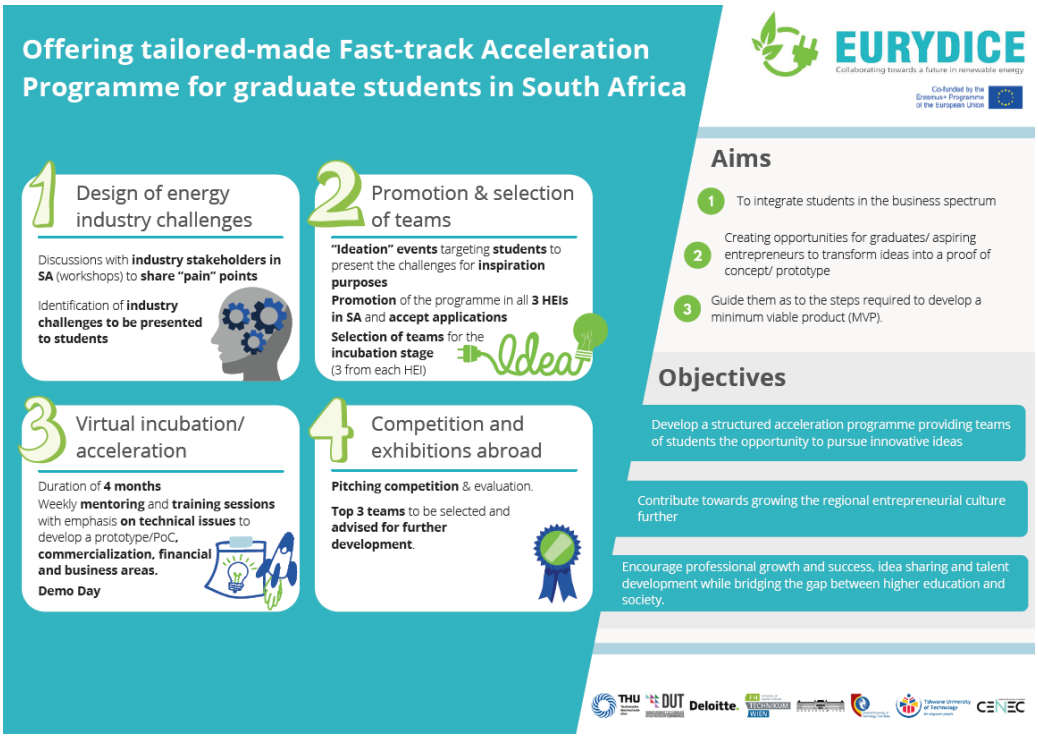

Figure 3: Steps of the tailored-made Fast-track Acceleration Programme for the graduate students in South Africa

3 CONCLUSION AND NEXT STEPS

The foreseen results are improving the quality of higher education and are enhancing its relevance for the labor market and society. The faculty management in the HEIs highly supports the project, because they see a big step towards their faculty goals. Due to these common objectives of HEIs and the project, it is realistic that the curriculum enhancements on several levels will be integrated into the universities curriculum by the universities faculties. In the next years, the students' employability will be increased through industry exposure and relevant labs (Open and Mobile) as well as exposure to international experts and students and entrepreneurial competence.

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ENERGY SUPPLY OF THE FUTURE: COMPARISON OF SMART GRIDS STUDY MODELS

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Abstract. *The reliable supply of energy is an essential prerequisite for prosperity and social security. The transition away from fossil primary energy sources is planned worldwide, while the acceptance of nuclear energy is limited. This implies large-scale grid integration of renewable energy generation, mainly photovoltaics (PV) and wind power, according to current knowledge. Increased penetration of renewable energy in existing power networks introduces major challenges in terms of the design and operation of these future grids, as well as in terms of the economic considerations that apply. It is widely recognized that students, as well as practicing energy professionals, have to be educated and trained to support this transition in energy systems.*

Keywords: Universities of Tomorrow, Global, Interdisciplinary, Digitized, Sustainable

1 STRUCTURES OF ENERGY SUPPLY AND MOTIVATIONS FOR SMART GRID APPROACHES

The current supply of energy worldwide is essentially from fossil primary energy sources, as shown in Fig. 1 for the world primary energy consumption by fuel for 2020. The use of nuclear energy plays a minor and decreasing role worldwide overall.

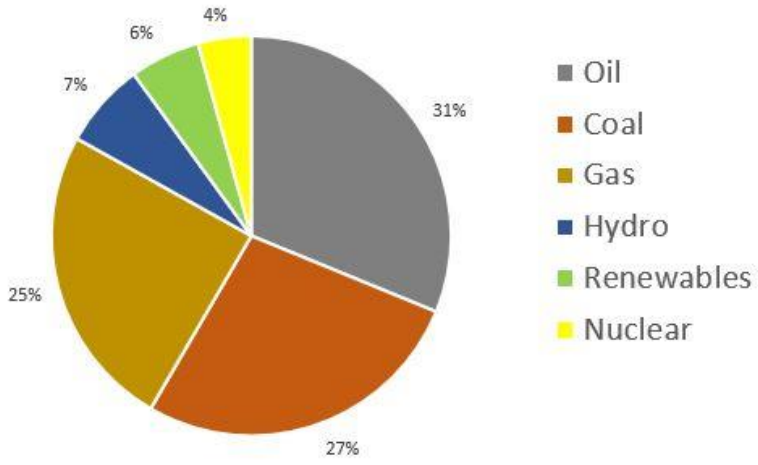

Figure 1: World primary energy consumption by fuel. Adapted from Statista (2017)[1]

End-uses can typically be divided into consumer groups or specific applications themselves, including the following:

- Industry

- Transportation
- Households
- Business, trade, and services

In Germany, the transition began more than two decades ago with the 1991 "*Act on the Feeding of Electricity from Renewable Energy Sources into the Public Grid*" and its successors in the "*Renewable Energy Act*" of 2000. The physical characteristics of the German grid are, nevertheless, still largely determined by large power plants.

For the reference countries considered here, namely South Africa and Germany, the shares of renewable primary energy sources in 2018 amounted to approximately 10% and 15% respectively[2]. Table 1 summarizes the gross energy generated for the two countries.

Table 1: Generation and exchange of electric energy 2018[2]

2018	Germany	South Africa
Gross generation	613 TWh	235 TWh
Gross generation per capita	6,5 MWh	4,0 TWh
Export	79 TWh	11 TWh
Import	28 TWh	17 TWh

The export and import figures listed in Table 1 show that both countries exchange electrical power with neighboring countries, which can contribute to grid stabilization. There are, nevertheless, significant differences in the stability of supply. Germany has a supply interruption of about 12 to 15 minutes per end consumer and year, while the South African grid has been experiencing severe generation capacity constraints from 2008 to date, partly due to delays in the commissioning of new-built thermal stations and maintenance challenges associated with the aging existing fleet. This has given rise to frequent load shedding episodes since 2008. In 2020, for instance, these interruptions amounted to 859 hours of scheduled load shedding across all load sectors[3]. The constraints in the available baseload generation, furthermore, result in an extensive use of expensive peaking generation such as Open Cycle Gas Turbines (OCGT).

Due to substantial reserves of low-cost coal, energy generation in South Africa has historically been largely based on fossil fuels. In this context, it is noteworthy that, by November 2018, the country had a total domestic energy generation capacity of the order of 54 GW, of which approximately 39 GW is represented by coal-fired thermal power stations and 3.5 GW by wind and solar PV renewable energy resources[4]. This yields a wind and solar PV component of the order of 6.5%. South Africa has, however, excellent wind and solar resources. The 2019 Integrated Resource Plan (IRP2109)[4], projects a scenario where the generation capacity is expected to grow to 77.834 GW by 2030, where the energy mix is expected to include approximately 11,5 GW of wind energy and 8 GW of solar PV energy, i.e., of the order of 25.6% of the generation fleet. About 18.000 MW has already been committed under the Renewable Energy Independent Power Producer Procurement Programme (REIPPP) and the local utility new build programme. As such, the country is in the initial stage of the transition from a predominantly coal-based energy scenario to wind and solar-based generation fleet.

2 SMART GRIDS OVERVIEW

2.1 INTRODUCTION

PV and wind power are volatile energy sources, that are characterized by a high degree of uncertainty. The classical widespread control of the generation of electrical energy, which follows demand, must therefore be abandoned. Consumption must, furthermore, be oriented to the availability of supply, which translates to the increasing importance of demand-side management. This shift in generation focal points usually requires changes in the electrical grid topologies and structures. In addition, different forms of energy

storage must be further incorporated in order to be able to use possible excess capacities of electrical generation on the one hand and to produce synthetic fuels to a sufficient extent on the other. These synthetic fuels might be used in the area of heating and mobility, enabling the operation of existing combustion technology and the respective logistics.

The coordination of market participants, including power plants, grid infrastructure, storage facilities, and end-users, requires the expansion of existing and the development of additional communication structures. In this context, decentralized logic, based on the evaluation of grid parameters, is just as important as the expansion of regional and central control.

2.2 SOME EXEMPLARY SMART GRID CHALLENGES

Renewable energy converters can be installed in a decentralized manner or, as in the European case, in a highly concentrated manner such as offshore wind turbines that feed into the transmission grid in only a few central switchgear. This results in expansion of the transmission and distribution grids, which is associated with investment needs and obtaining public acceptance as well as complex approval procedures.

The volatility of renewable energy generation, and lack of complementarity with demand, give rise to a need for storage systems, ranging from short-term storage to seasonal long-term storage.

In the event of major disturbances in the grid, i.e., short-term imbalances between generation and load, the power frequency is supported by the inertia of turbines and generators in the so-called instantaneous reserve. Modern wind turbines, however, are usually coupled to the grid via frequency converters and cannot directly contribute rotating mass for stabilization. PV plants with inverters also do not provide inertia. With the high penetration of renewables in the grid, rapid response storage systems must therefore be introduced to support the grid as "artificial inertia"[5].

Conventional electric power systems are designed to facilitate the flow of power from the transmission grid, through the distribution grid, to the last load. With the introduction of distributed generators, power flow can be temporarily reversed. This necessitates changes in protection technology and voltage stability control.

Addressing the generation and transmission challenges faced by modern electricity supply grids, especially in view of the worldwide transition to renewable energy-based generation fleets, requires well-skilled technical labour forces that can plan, design, implement, and operate the future power network in line with international best practices. In this context, smart grid education represents an important aspect of the reskilling and upskilling of the labour force required to manage this transition process, especially in developing countries.

3. SMART GRID STUDY PROGRAM DESIGN

The multi-layered requirements for designing and operating smart grid networks must be reflected in corresponding study program concepts. This, first of all, naturally includes mathematical, scientific, and engineering fundamentals, which are indispensable for later specialization. Then, based on this basic knowledge, the different specialized aspects are to be deepened in detail.

At Stellenbosch University, for example, this is done as part of structured postgraduate programs, namely a “Postgraduate Diploma in Engineering (Smart Grid Technology)”6 and a “Structured MEng in Smart Grid Technology”7 The associated program structures adopt a layered approach, such that each program incorporates a number of common modules to cover fundamentals and some overarching topics, a number of compulsory modules aimed at smart grid fundamentals, and a number of elective modules to accommodate specific fields of specialization. The current structures can be summarized as follows:

Common modules:

Data Science	Department of Industrial Engineering

Project Management	Department of Industrial Engineering
Project Economics and Finance	Department of Civil Engineering
Numerical Methods	Department of Applied Mathematics
Advanced Topics in Engineering Management	Department of Industrial Engineering
Compulsory modules:	
Smart Grid Technology Overview	Department of E&E Engineering
Integrated Supply-Side Technology	Department of E&E Engineering
Smart Grid Communications	Department of E&E Engineering
Integrated Demand Side Technology	Department of E&E Engineering
Elective modules:	
Advanced PV Systems	Department of E&E Engineering
Energy Storage Systems	Department of E&E Engineering
Wind Energy	Department of M&M Engineering

These modules are supplemented by a final project assignment. These projects are typically linked to one of the elective specialization modules. In total, the programs have a student workload of 180 credits, corresponding to approximately 90 ECTS-CP.

Education aimed at managing the transition to future grid scenarios, particularly in developing countries, faces a further challenge in the sense that smart grid approaches represent an important aspect of the reskill and upskill processes required by the existing labour force. In this context, the modular smart grid education programs at Stellenbosch University have been structured to facilitate continuing education processes, whereby practicing energy professionals can acquire further accredited training in these concepts, without necessarily enrolling for a degree. As a result, the modules are offered using a hybrid approach, whereby face-to-face lectured and tutorials are available to resident students, while industry participants have access through interactive streaming services.

At HTWG, the respective modules are not summarized in one study program only, but distributed as compulsory and elective courses in Bachelor and Master programs for Engineering students as well as for students of “Engineering and Management”. Not all of these modules are strictly focused on smart grids applications but cover different disciplines. Bachelor's students have the opportunity to choose different majors. In the field of engineering, this is the major "Energy Systems", in the field of engineering and management the major is "Energy Management". The choice of specializations, as well as additional elective modules, then results in the necessary competence to work successfully on the design of smart grids. The bachelor modules related to smart grid aspects are as follows:

Electric Power Systems / Energy Supply
Smart Grids
Control Systems
Automation Technology
Communication Systems
Power Electronics
Entrepreneurship
Business Laws

In the master's programs, there are extensive options for choosing relevant modules, including the following:

Advanced Electric Power Systems
Sustainable Management of Resources
Simulation of Renewable Energy Systems
PV and Wind Power Systems
Advanced Communication Systems

The Bachelor program with 210 ECTS-CP in total is finished with a thesis of 12 ECTS-CP, the Master programs (90 ECTS-CP in total) with a thesis of 30 ECTS-CP.

Results from research projects are incorporated into courses, and thesis can be part of research projects. As an example, a reference is made to work on optimized network management through the use of neural networks.[8]

4 SUMMARY

The ongoing transition of power systems towards sustainable smart grids scenarios involves a number of disruptive technologies that require innovative approaches to prepare the workforce for designing, implementing, and operating the emerging power networks. Educating students to prepare for successful participation in the development and implementation of these energy solutions is the task of higher education today and in the future. Study program concepts of HTWG Konstanz and Stellenbosch University (SU) are different in the design of study programs: integration of the topics into a consecutive study program concept based on compulsory and elective subjects at HTWG as well as complete programs designated with the title "Smart Grids" at SU. The aim is identical to in many other universities worldwide.

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#CLIMATECHALLENGE: REAL-WORLD-EXPERIMENTS FOR CLIMATE ACTION AS A CONTRIBUTION TO HIGHER EDUCATION FOR SUSTAINABLE DEVELOPMENT

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Abstract. *Tackling the climate crisis is probably the most important challenge of our time. Empowering students to play their part as change agents for a decarbonized world is, therefore, a key task of universities of today and tomorrow. We have experienced that acquiring knowledge does not necessarily lead to students taking action. This phenomenon is called "knowledge-behaviour-gap" and it has been found to be widespread. We wanted to overcome this gap and unleash the full potential in this transition. Therefore, we developed the hands-on teaching format #climatechallenge with real-world-experiments at its core.*

To connect the climate issue to the personal level, a #climatechallenge starts with calculating the carbon footprint. By comparing their individual carbon footprints students discover so-called big points which are personal lifestyle choices that cause many carbon emissions. Students then choose a 4-week change experiment based on their individual big points – their footprint challenge (e.g. dietary choices like a plant-based diet; or rethinking mobility habits). Students usually encounter certain structural barriers during their footprint challenge, e.g. climate-friendly behaviour may be more costly or more time-consuming. They realize that structures like regulatory frameworks and price structures matter, too, as they guide behaviour. To also include this other side of change, we lead students into a second experiment, called the handprint challenge. They identify starting points for small actions they then take on to contribute to structural changes.

Our experience with more than 1,000 participants since 2016 is that students appreciate this hands-on-approach to learning and actively enact positive change. They experience self-efficacy – an important predictor for taking action in the future. Furthermore, teaching with the #climatechallenge format has a large potential for collaboration: Some of our courses include students of different faculties and also of both the University of Applied Science and the University in Konstanz.

Keywords: Sustainability Transition, Higher Education for Sustainable Development, Real-world-experiments, Change Agents, Climate Action

1 THE BEGINNINGS

The ongoing climate crisis has been scientifically documented [1; 2]. There is consensus among climate scientists that humanity is causing global heating [3]. Therefore, the international community agreed in the Paris Agreement to limit global warming to below 1.5 degrees if possible [4]. Projections demonstrate that Germany has to become climate neutral by 2035 to make its contribution to this agreement [5] – a major challenge and transition!

We are convinced that as university lecturers we have a social responsibility to prepare students for a role as change agents. We believe that we need to empower them to play an active part in shaping the ongoing sustainability transition. Thus, in 2013, we started our first attempts to live up to this responsibility. We

designed a course that focused on a carefully compiled canon of professional and interdisciplinary knowledge on the climate crisis and climate protection. The results were sobering: although exams showed that the students were able to reproduce this body of knowledge, we didn't see any activities arising from this. We had failed to motivate them to act.

We identified two reasons for this: First, knowledge about climate protection does not automatically motivate people to act on this knowledge. In the literature, this so-called "attitude-behavior-gap" is described in many examples, not only for the group of students [e.g. 6; 7]. Second, transforming our societies to become carbon neutral is a challenge of an immense magnitude, in Germany referred to as the Great Transition [8]. Also, it is clear that the climate protection measures adopted in Germany so far are not sufficient to meet the German climate protection targets of 2030 and 2040 [9]. We have the impression, higher education institutions and professional practice to politics are only adapting slowly to the challenges of the climate crisis, despite the strong activism of the Fridays For Future movement. But still, there is a sense of powerlessness among some students.

Based on this analysis, we have developed the #climatechallenge teaching and learning format since 2014.

2 TEACHING WITH THE #CLIMATECHALLENGE

The teaching and learning format #climatechallenge is used in alternative versions in courses at different universities. In the following, the focus of the description is on #climatechallenge as a "stand-alone" course. Other variants are briefly reported at the end of this section.

2.1 LEARNING OBJECTIVES

The objective of #climatechallenge is a teaching that reaches head, heart, and hands (that can be traced back to Pestalozzi 1746–1827, also adopted by the Transition Town movement [10]). The practical self-experience in the experiments of the climate challenge nurtures a positive image of one's own active role in the transition towards a climate-friendly society. We want to support students in their personal development as critically thinking and responsible consumers and citizens in the Anthropocene.

2.2 CONCEPT

A #climatechallenge consists of two consecutive real-world-experiments [11], bringing more climate protection in one's own lifestyle. In the first 30 days which are the first part of the challenge, each student starts a specific change experiment, directed towards the reduction of their carbon footprint [12] e.g. in the areas of nutrition, mobility, or consumption (= footprint challenge). In the second part, students develop and test approaches for transformative political or social engagement (= handprint challenge [13]) and become active. In doing so, they aim to contribute to overcoming non-sustainable structures and framework conditions in society, e.g. laws, infrastructures, narratives, and social norms [14]. The handprint challenge follows the logic of making climate action easier for others.

2.3 STRUCTURE, CONTENT, AND METHODS

When we start the footprint challenge, students are first introduced to basic concepts of the climate crisis [e.g. 15]. Following that, we bring climate to a personal level: Students calculate their personal carbon footprints[1]. By comparing the carbon footprints of students in the course we identify "Big Points" [16] – lifestyle decisions that have a big impact on carbon emissions. Each student then chooses one such Big Point for a change experiment, which becomes their footprint challenge for the next four weeks.

Based on issues experienced during the footprint challenge, structural barriers are identified (e.g. "it is more expensive", "it takes more time", "there is no offer for it"). We lead students into a handprint challenge, that

[1] https://uba.co2-rechner.de/

addresses such a barrier as a form of socio-political engagement [13, 17]. Adding to this, we introduce students to the concepts of the great transition or sustainability transition [e.g. 8] and the ordonomic perspective [e.g. 18]. This provokes the question of whether their handprint challenge might even be more relevant for the sustainability transition than their footprint challenge. To investigate this question in more depth, we have presented a first theory draft of the Footprint-Handprint-Gap [19].

Throughout the whole course, students are encouraged to explore these two different levels of individual and "structure-changing" activities for environmental protection in their everyday life. A selection of relevant literature is provided during the learning process. The self-experiments contribute to both the motivation and consolidation of the acquired knowledge. In addition, we encourage participants to formulate and share their individual challenges as personal stories. This adds aspects of effective sustainability communication, going beyond facts. Participants' stories are shared in the course as well as via the website www.climatechallenge.cc.

Thus, the seminar contributes to higher education for sustainable development, and at the same time promotes the emergence, planning, and implementation of transformation processes in the personal and supra-personal sphere; in a broader sense to the development of competencies for sustainable development [20].

2.4 #CLIMATECHALLENGE IN OTHER CONTEXTS

#climatechallenge runs as described above via an independent course (currently e.g. 2-3 credits in the Studium Generale and Required Elective at the University of Applied Science HTWG Konstanz and in Key Qualifications and Teacher Training at the University of Konstanz, all Germany). In addition, #climatechallenge is also used as a supplement in courses related to sustainability (e.g. course "Sustainable Economics 1" overall 4 credits, University of Applied Science Konstanz).

We want to share the learning format #climatechallenge widely. For example, it was presented to interested lecturers in the Education for Sustainable Development Workshop of the Department of Technology and Science Ethics (rtwe) in Baden-Wurttemberg, in the journal of the German Association of University Teachers [21] and we highlighted the potential of the format #climatechallenge for Corporate Social Responsibility [22]. We have received feedback from other university teachers using the format at other universities. Furthermore, we have supported students to bring the #climatechallenge to schools, and we are currently prototyping an application in the context of a local company.

3 #CLIMATECHALLENGE AS PART OF ESD

The teaching and learning format #climatechallenge includes different aspects that are relevant in the context of education for sustainable development (ESD):

3.1 INNOVATIVE & PRACTICAL APPROACH

Coming from one's own behavior and possibilities for individual action for climate protection offers an innovative and real-life entry-point to sustainable development – with a focus on Sustainable Development Goals 4.7 "Quality Education" with a strong emphasis on Education for Sustainable Development and 13 "Climate Action". The perspective of individual actions to optimize the personal carbon footprint is followed by taking a perspective of systemic changes – and testing out individual contributions to these systemic changes (handprint).

3.2 CRITICAL ANALYSIS AND CREATIVE EXPERIMENTATION

There is a critical examination of one's own everyday decisions and creative experimenting with sustainable alternatives. Participants experience the hard way, that their options for footprint action are also strongly determined by the structural framework they live in, and that these structures are often not so supportive yet (see also: structuration theory [14]). This makes participants realize that structures play an important role and it motivates them to explore one's own leverages to change these structures over time (handprint).

3.3 THEORY-PRACTICE TRANSFER

With its approach of overcoming the knowledge-behavior gap, #climatechallenge is a tool of theory-practice transfer: theory is directly applied and tested in practice (e.g. theory: German national greenhouse gas emissions, and a bundle of measures for climate protection; practice: determine one's own carbon footprint; jointly developing a theory from practical experience: identify points from personal carbon footprint which have a particularly large climate impact (= Big Points); practice: take up a Big Point for one's own change experiment).

Practical experiences then motivate participants to deal with theoretical approaches again (e.g. ordonomic perspective and structural framework, its possibilities to influence these via subsequent practical transformative engagement resp. handprint actions.

3.4 TRANSFORMATIVE LEARNING PROCESSES

The learning process within the #climatechallenge is transformative [23] in that it invites people to develop and implement solutions for their own lifestyle issues. Possible actions to change structures are explored and often piloted. The transformative effect consists of changes of the involved persons (learners, teachers, environment), regarding knowledge, actions, and attitudes. Furthermore, real-life structures are addressed through the handprint challenges – although these changes are less quickly visible and clearly attributable, we also assume a transformative effect here.

3.5 REFLECTION ON NORMS AND VALUES

One's own actions and the experience of being able to be part of the solution is a good basis for a transformative mindset – a mindset that both admits the climate crisis and the immense threats posed by it, and questions common unsustainable norms and values. The experiences in the #climatechallenge can be used as a basis for value-based communication on sustainability, also in other contexts.

3.6 CO-DESIGN AND RESPONSIBILITY FOR THE LEARNING PROCESS

Participants choose their own footprint and handprint challenge and they develop their own approach of action. While this process is accompanied by the teacher's support, learners take considerable responsibility for their own learning process here.

Especially in the context of the handprint challenge, #climatechallenge encourages collaborative work. This handprint action can again aim at initiating further learning processes: For example, the initiative to bring more education for sustainable development into the teacher training program at the University of Konstanz arose in the context of a prior handprint challenge. The format "#climatechallenge goes Lehramt (= Teacher Education)" is currently being designed by three students with the support of the Student Council for Teacher Education and takes place for the first time in winter semester 2021/22. The initiative was nominated by the University of Konstanz for the special award for outstanding student engagement at the Baden-Wurttemberg Teaching Award.

3.7 EXPERIENCE OF SELF-EFFICACY

Last but not least, the #climatechallenge provides experiences of self-efficacy – and thus also lays an important foundation for future action of all kinds.

4 CONCLUSIONS

As shown above, the learning format #climatechallenge contributes to different aspects and competencies believed to foster sustainability action in our society. The reports in which students record their #climatechallenges and their learning experiences confirm this, as do the evaluation results and individual feedback

from students. In 2021, #climatechallenge was awarded the 1st prize by the Heidelberg Center for Education for Sustainable Development.

We are happy to share the format and our experiences. We share the teaching material we use (e.g., ppt slides, a detailed schedule, and storyboard for all lessons, worksheets, and handouts) via our website www.climatechallenge.cc (so far German only, we are in the process of going international and happy for support in transferring this material).

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ENGLISH-MEDIUM INSTRUCTION (EMI) IN GERMAN UNIVERSITIES: POSITIONS AND RESEARCH FINDINGS

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Abstract. *For some years, universities in countries where the first language is not English choose English as the medium of instruction. In German universities, instruction in German is still the dominant form, which makes university study in Germany less accessible to international students. To attract international students and to improve career prospects for home students, many German universities offer programmes taught in English or in a combination of German and English. It is widely expected that the implementation of EMI-programmes leads to improvements in English language proficiency (ELP). However, it has emerged that substantial gains in ELP in EMI programmes will only occur as the result of content and language integrated learning.*

Keywords: English-Medium Instruction (EMI), English for Academic Purposes (EAP), Content and language integrated learning (CLIL)

1 INTRODUCTION

This introduction into English-Medium Instruction (EMI) focuses on practices at the Universities of Applied Sciences (UAS) in the state of Baden-Wuerttemberg (BW). The main aim of the paper is to present current debates around EMI and the language aspects involved in EMI. From a language learning perspective, EMI programmes on the Bachelor‘s level are particularly interesting, because students are introduced to their academic subject in a foreign language; students learn new concepts, new terminology and the discourse in their discipline in a new language.

The paper consists of four sections: It starts with an overview of types of EMI and of the prevalence of EMI. The main reasons for the introduction of EMI programmes are presented and discussed, followed by an overview of current debates about EMI. The paper finishes with a conclusion and recommendations for teaching and research.

2 EMI: DEFINITIONS, TYPES AND DEVELOPMENTS

EMI is an umbrella term, which is used for a range of settings. The following terms are used for similar settings: English as the medium of instruction, English-medium degree programmes, English-medium education or English-based content instruction.[1] According to a widely used definition, EMI is "*The use of the English language to teach academic subjects (other than English itself) in countries where the first language of the majority of the population is not English*".[2] This is a descriptive characterization of EMI programmes where language is viewed as a tool and not as a goal. By contrast, in the following definition language outcomes are regarded as central to EMI: "*EMI involves a setting in which at least some participants have another L1 than English, but in which all are expected to use English for some instructional purposes, and in which English is not taught but is nonetheless expected to be learned*".[3] The expectation that EMI leads to a significant growth in English language proficiency (ELP) is probably true for most, but not all EMI settings.

Content and language integrated learning (CLIL) has a more explicit focus on language learning: Language teaching is part of the instruction and an increase in content knowledge is supposed to happen in conjunction with improvements in language proficiency. Courses are usually taught by language teachers or by teams comprised of language and content teachers. Pecorari and Malström suggest that all EMI programmes are designed with CLIL in mind: "*EMI involves an educational setting in which language learning objectives are in symbiosis rather than in tension with subject content objectives; and in which good planning ensures that the preconditions for success are in place, and that the acquisition of English is incidental, but not accidental*".[4]

In *full EMI* programmes, the language of instruction is English only. *Partial EMI* programmes include teaching in German as well. A distinction can be made between a phased English to German model, a phased German to English model or a parallel German and English model. The business degree at Konstanz UAS can be taken as an example for a phased German to English model. In the first semesters, all courses, apart from courses in Business English, are taught in German. In the latter stages of the course, some modules which are mandatory are taught in English.

In Europe, EMI is particularly widespread in the Netherlands and in the Nordic countries. In Asia, growth is particularly strong in Japan and South Korea, and to a lesser extent in Taiwan and China.[5] While there was a marked growth in Europe between 2007 and 2014[6], the number of new EMI programmes seems to be levelling off. In 2021, there were 166 Bachelor programmes and 1152 Master EMI programmes in Germany according to the database of the German Academic Exchange Service. In BW, where the introduction of EMI courses and MOOCs (Massive Open Online Courses) in English were supported by grants totalling one Mio. Euros in 2014[7], there are currently 6 EMI Bachelor programmes and 39 Master programmes at the 24 UAS. They are mostly in IT, engineering and business subjects.

3 REASONS FOR INTRODUCING EMI

Surveys have shown that EMI programmes tend to be introduced through a top-down, policy driven process.[8] The overarching reason associated with EMI is the effort to internationalize the university. Internationalization is seen as a necessity by university leaders, and EMI is often regarded as a cornerstone of the internationalization strategy.[9] EMI is championed because of the prestige and the reputation of English as an international language, it is associated with the recruitment of international students, the recruitment of international members of staff and also with fostering international research outputs. For EMI programmes at the UAS, some of these considerations are less relevant. For example, recruitment of international staff is difficult for the UAS, because the typical career of an academic in Anglophone countries does not include five years in a company environment.

Attracting international students in order to prop up student numbers has been a very important reason for the introduction of *full EMI* programmes at the UAS in BW. The EMI Bachelor programmes in engineering were established for the sole reason that the programmes taught in German did not attract enough home students.[10] Universities faced a choice between closing the programme and finding new students. They tried to attract international students for whom studying in the German language was not an option. At present (2021), most of the students on the full EMI courses come from India and neighbouring countries.[11] There are hardly any home students in the EMI Bachelor programmes in engineering. Apparently, being taught engineering subjects in English does not appeal to home students. Thanks to the additional student intake, EMI saved the struggling engineering degrees. At the same time, the UAS seem reluctant to expand such programmes and it seems that full EMI programmes will continue to be a niche product. A contributing factor is that attracting international students for full EMI programmes is by no means straightforward. It requires considerable effort to turn the large initial interest in EMI programmes into "bums on seats". Establishing EMI programmes requires committed members of staff who advise and support potential students on their protracted route from India to a UAS in a small German town.

Finally, EMI is introduced with a view to benefit German speaking students. This is especially true for the *partial EMI* programmes mentioned before where a phased German to English model is used. Studying in an English-speaking environment is supposed to increase career prospects of home students in an increasingly international and English speaking working environment. This is the main reason for the introduction of partial EMI programmes. It implies that gains in ELP are a likely outcome and it is assumed that students learn academic content through English in the same way they learn new content in German.[12]

4 DEBATES ABOUT THE IMPACT OF EMI

EMI has led to debates and to some, albeit rather limited research activities with often inconclusive findings. Moreover, the interpretation of research results is complicated by the diversity of EMI settings. This diversity pertains to the kind of EMI programme, the teachers and the students and their linguistic, cultural and educational backgrounds. The following aspects have been the focus of research and debate: (1) Are content teachers able to teach academic subjects through English? (2) Is there a cost to content learning and academic achievement? (3) Does EMI really lead to gains in ELP? (4) Does EMI disadvantage students with lower ELP? Is it fair? (5) Does EMI restrict academic development in German? More poignantly: Does EMI privilege Anglo-American cultural and linguistic expression?

In this part of the paper, I will present a summary of research findings underpinning the debates and offer my views and conclusions with regard to the specific circumstances of the UAS in BW.

4.1 VIEWS AND COMPETENCES OF TEACHING STAFF: ARE CONTENT TEACHERS ABLE TO TEACH ACADEMIC SUBJECTS THROUGH ENGLISH?

There are countless studies into teachers' beliefs on EMI.[13] In summary, the following points emerge: Content EMI lecturers understand the need of EMI and perceive the advantages. However, they express concerns about their own English proficiency and complain about a lack of preparation and the extra work they have to put in. Studies reveal that teachers in EMI programmes are concerned about the students and comment on the fairness of EMI and the language demands. However, they do not feel responsible for language aspects.[14]

The concerns about ELP are to be taken seriously because the linguistic demands of EMI are high. Thielmann concluded from his analyses of EMI seminars in Chemistry that the lecturers struggled to teach and the students struggled to make sense of it. The outcome fell woefully short of the supposed learning aims.[15] Incidentally, teachers' concern about their own English language proficiency correlates with age. Younger lecturers seem to believe that their ELP is sufficient for EMI. They may not realize that EMI does not mean teaching in a *lingua franca* but teaching in a different academic language.

4.2 ACADEMIC ACHIEVEMENT: DOES EMI HAVE A DETRIMENTAL EFFECT ON CONTENT LEARNING?

Research on the question of content learning is limited. Results are inconclusive but studies with a control group usually show that non-EMI groups achieve better results.[16] However, a study from Austria, for example, evaluated achievements in a physics test and found no statistical difference between EMI and non-EMI groups.[17]

Grades of EMI students in one of the EMI engineering courses in BW are approximately one grade below non-EMI students.[18] This difference may not be entirely attributable to difficulties with learning in a foreign language because students on the EMI course come mainly from India and neighbouring countries. They have a different educational background and study in a foreign university system. In these cases, differences in exam grades are unlikely to be the result of EMI alone. The example illustrates that it is difficult to draw general conclusions on this issue.

4.3 EMI AND ELP: DOES EMI LEAD TO GAINS IN ENGLISH LANGUAGE PROFICIENCY?

Improvements in ELP are often an expected outcome of EMI programmes.[19] From a second language acquisition perspective, some arguments can be made in support of these expectations: EMI fulfils Stephen Krashen's conditions set out in his Input Hypothesis, which posits that learners need input and that this input needs to be comprehensible and abundantly available.[20] However, as Merrill Swain argued, there also needs to be output, this means that students need to consciously produce language through speaking and writing.[21] Similarly, Richard Schmidt proposed in his Noticing Hypothesis of language learning that there needs to be conscious processing in addition to language input.[22] In summary, some acquisition may take place in EMI, but this may have more to do with absorbing language rather than learning a language through rules and systematic training.

Again, there is surprisingly little research into this important aspect. Existing studies tend to be poorly designed.[23] They lack, for example, a control group. Some studies conclude that EMI students show improvements in listening comprehension[24] and that students pick up features such as discourse markers of their lecturers. Another finding is that gains in ELP of EMI students are not much larger than gains of non-EMI students in similar programmes.[25] A typical summary reads: "Results showed no statistically significant effect of medium of instruction on English proficiency".[26] Some reasons for these disappointing outcomes have already been presented: a lack of noticing, not enough conscious output or reflection on language. Another reason is that non-EMI students also improve their EL skills during their time at university. The comparative advantage of EMI students seems to be small and it is difficult to show small differences that occur over a long period on a complex construct such as language proficiency. Lastly, research designs may also play a role: Language proficiency is measured with general language proficiency tests. It may be that gains of EMI students do not necessarily translate into improvements in general language proficiency.[27]

The emerging picture is that without additional support in English for Specific Purposes (ESP) or English for Academic Purposes (EAP), EMI programmes probably do not lead to the expected substantial gains in ELP.

4.4 FAIRNESS: HOW CAN WE GUARANTEE FAIRNESS IF ACADEMIC PROGRESS IS BASED ON ENGLISH LANGUAGE PROFICIENCY?

A well designed, multi-factorial study showed ELP to be the strongest predictor of success in EMI.[28] The correlation of ELP with academic success in EMI programmes, which was also shown in other studies[29], gives rise to a number of concerns.[30] Should ELP be part of the construct of content exams? This would disadvantage those who speak English less well. Do we want to exclude students with low ELP from academic study? Many universities have reacted to such concerns by giving students a choice of language in exams. Again, this concern strengthens the case for additional English language support.

4.5 'ENGLISHIZATION' AND THE FUTURE OF GERMAN AS AN ACADEMIC LANGUAGE: DOES EMI RESTRICT SCIENTIFIC AND ACADEMIC DEVELOPMENT IN GERMAN?

The growing popularity of EMI programmes has led to some concerns – not just from a *deutschtümelnde* (German chauvinist) perspective.[31] Does EMI inadvertently lead to monolingualism in academia and does it pose a threat to the development of science? The argument is that scientific and conceptual developments are more differentiated and more nuanced if they happen in different languages.

Does EMI pose a threat to German as an academic language? German scholars also point to the possible unintended consequences of the use of English in teaching and research to the German language. It is feared that German as an academic language will not develop further and be impoverished if there is no need to present new thoughts, concepts and ideas in German.[32]

Furthermore, do EMI and more generally the Englishization of academia contribute to Anglo-American cultural and linguistic dominance? The concern is that language is not just a tool but also a vehicle for

culture and thought. The dominance of one language may lead to a reduction of cultural and conceptual diversity in academia.[33]

These concerns need to be taken seriously. They are, however, based on universal developments with regard to language use in academia. Partial EMI programmes in particular are unlikely to play a major role for this.

5 CONCLUSION AND RECOMMENDATIONS

Full EMI programmes have been introduced to increase the number of students in particular subjects. There does not seem to be much interest from home students for full EMI programmes at Bachelor level. At the UAS in BW, full EMI programmes are likely to remain a niche product. The growth of such programmes is levelling off and it will not reach similar levels in Germany as in the Netherlands or in Nordic countries. Partial EMI programmes are intended for the benefit of home students and to accommodate exchange students. I expect a further increase of partial EMI programmes albeit at a slower pace. Such programmes will become the norm rather than the exception.

EMI is a transformative force in German higher education. EMI programmes should be accompanied by a clear strategy. For EMI to translate into gains in ELP, it is advisable to integrate language learning with subject content learning. This applies to content lectures, which ought to consider language-learning principles, and to language courses, for example courses in EAP or courses in ESP, which ought to consider content-related topics. A notable example is the business degree at Konstanz UAS where courses in business English amplify the benefits of the EMI lectures.

Content teachers play a crucial role for the success of EMI. They need to be aware of the demands on academic English and the implications of EMI and CLIL. They need a basic understanding of what it means to learn a subject through a foreign language and be familiar with lexical development and methods from language pedagogy such as scaffolding. Content teachers need to overcome their reluctance to consider language aspects and realize the benefits for learning outcomes.

Finally, we should encourage more research into the effects of EMI, both quantitative and qualitative. There is a dearth of research on EMI and academic achievement as well as on EMI and the impact on ELP. Such research should be longitudinal; it should include control groups and consider outcomes measured by assessments rather than self-reports alone.

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LAKE CONSTANCE 5D-CONFERENCE – INTERNATIONAL BENCHMARK IN CONSTRUCTION MANAGEMENT MEETS UNIVERSITY

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Abstract. *This document deals with the background, the aims, the output, and the other benefits for students of Lake Constance 5D-Conference, the first application-oriented BIM conference in construction management in Germany.*

Keywords: Universities of Tomorrow, Global, Interdisciplinary, Digitized, Building Information Modelling, BIM, 5D-Conference

1 INTRODUCTION

The evolution of construction management is actually driven by Building Information Modelling (BIM), in parts of Europe it is called 5D. BIM or 5D means the common development of a 3D-digital model by all involved in a construction project from the first idea to the design, the construction, and the maintenance. For the aim, to build up a strong tool for simulation and visualisation, each project partner has to fill the own project results into the BIM model, for example, information about costs, time scheduling, sustainability, etc.

At the beginning of this working as a professor at HTWG Konstanz. Dr. Uwe Rickers decided in 2010 to integrate BIM in his teaching and research activities. He realized the following results:

- In 2012 the first BIM-lecture (3 ECTS) in the field of construction management started at a University in Germany
- in 2013 began the installation of the BIM-Lab of the faculty of civil engineering, the first one in the field of construction management at a University in Germany
- in 2012, 2013, 2015, 2016 and 2018 he organized in cooperation with the 5D-Initiative of the European Construction Industry the Lake Constance 5D-Conference (http://htwg-konstanz.de/5d), the first application-oriented BIM-Conference in Germany. Each conference was visited by circa 400 attendees.

2 LAKE CONSTANCE 5D-CONFERENCE

2.1 AIMS

The aims of all five conferences were to bring

- the international benchmark in BIM to the national construction and project management as a national practice
- the international benchmark in BIM to the education in construction management at HTWG Konstanz.

2.2 CONCEPT

The 5 conferences took place in the Konzil building in the harbor of Constance, for 2 days with the following structure and contents:

- 2 Keynote-Speakers
- up to 40 speeches in up to 5 parallel running sessions on all floors of the Konzil building, in 2015 and 2016 even additional aboard motorship MUNICH in the harbour
- plenary discussions
- a lab area for self-experiences in BIM-products and BIM-technologies
- an exposition area of the main sponsors and an exhibition area of sponsors
- a sail on Lake Constance with dinner and live music as an evening event.

2.3 OUTPUT

The output of the five conferences are

- 4 proceedings of the conference, edited at VDI [1], [2], [3], [4] and further publications, e.g. [5], [6], [7]
- medial presence in TV, radio, and print media
- lectureships at HTWG Konstanz by partners of the conference network
- sponsoring of a 3D-Laserscanner for HTWG Konstanz by one of the main sponsors
- sponsoring of excursions to construction sites by members of the 5D-Initiative of European Construction Industry
- sponsoring of personal security equipment for our students by one of the main sponsors.

2.4 OTHER BENEFITS FOR STUDENTS

Other benefits of the five conferences for students are

- free attendance to all conference rooms and labs, with the exception of the evening event
- high-class information about the international benchmark in BIM
- possibility to get in touch with high-class international contacts concerning BIM in the practical use
- possibility to be a member of the conference staff.

3 CONCLUSIONS

In the years 2012, 2013, 2015, 2016, and 2018 Dr. Uwe Rickers, professor for construction management at HTWG Konstanz, organized in cooperation with the 5D-Initiative of the European Construction Industry the „Lake Constance 5D-Conference“.

The conference in the year 2011 was the first application-oriented conference concerning Building Information Modeling (BIM) in Germany. BIM is an internationally established approach for digital support for the design, construction, and maintenance of buildings. In using BIM, all involved in a construction project have to build up a shared digital building model for simulation, visualisation, and documentation. It was the aim of the conferences to bring the international benchmarks in BIM-technologies to the German market.

The five Lake Constance 5D-Conferences included two days with speeches in parallel running sessions, experimental Lab-rooms, exhibition areas, and a high-class evening event with a sail on Lake Constance. Each of the conferences were visited by more than 400 international attendees.

Since 2011, the field of digitalisation of construction projects and BIM is a strong content of Prof. Uwe Rickers teachings in construction management. In the year 2012, the first stand-alone BIM-lecture (3 ECTS) concerning construction management was created at a German University, in 2013 was the beginning of the installation of the BIM-Lab at the faculty of civil engineering.

In this context, the participation in Lake Constance 5D-Conferences afforded students the opportunity to get in touch with the international Benchmarks in BIM. Except for the evening event, all speeches, the Lab-rooms, and the exhibition area were accessible out of fee for students. Thus, for students, the conferences offered the chance to get first-class knowledge and to get in touch with speakers, exhibitors, and visitors in the field of BIM in addition to lectures at HTWG Konstanz. The Students used these possibilities for their own development very intensely.

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POSTHUMANIST SANDBOX: THE POTENTIAL OF MULTIPLAYER - ENVIRONMENTS

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Abstract. *This paper seeks to reveal a novel assessment of creative production in academic education, re-evaluating the conceptual and artistic potential of virtual real-time collaboration through digital media. Allowing for transcultural exchange as well as global participation, this could positively influence the development of novel artistic approaches and innovative measures for universities by contributing to a more contemporary, location-independent, and ultimately more equal form of art and knowledge production.*

Reflecting on the COVID-19 pandemic in his essay ***Virus, Viralität, Virtualität*** *[1] Peter Weibel states, that the virus sheds light on the fragility of the so-called 'Nahgesellschaft', in which we still live, physically close to one another, even though for more than 20 years, remote forms of communication have become dominant in large parts of the world. Thus, new forms of individual and collective agency are required as well as interactive and hybrid types of space and production processes.*

We suggest a digital collaborative space that is supposedly post-ethnicity and post-gender, as only interactions with others define the players' identities, as shown in the discussion of Safari, an experimental digital learning environment developed in 2019 for a seminar at the ./studio3 – Institute of Experimental Architecture at the University of Innsbruck that was held by the author and others: Safari allowed up to 50 players to inhabit and manipulate the same shared virtual space. Players navigated through a game-like three-dimensional environment and were led through a series of experimental tasks to communively communally create architectural artefacts. Within a shared immersive environment, digital collaboration can encourage the unfolding of an emergent intermingling of expressive qualities while inducing novel means of co-existence and cooperative artistic decision-making.

Taking a post humanist stance, the conceptual value of such multiplayer environments will be proven by calling in Karen Barad's theory of agential realism based on the 'ontological inseparability of intra-acting agencies'[2] whereby matter and meaning do not preexist, but rather are co-constituted via intra-actions.

Keywords: Collaboration, Real-time, Multiplayer, Digital art, Architecture, Virtual space, Posthumanism, Agential realism, Performative ethics, Postgender

1 INTRODUCTION

This paper seeks to reveal a novel assessment of artistic education and production by re-evaluating collaborative design strategies and allowing a link to be created between the virtual and the physical world, using a quantum field theory approach and especially adopting feminist theorist Karen Barad's notion of agential realism. We want to 'cut together apart'[3] the apparently opposed terms of virtuality and materiality – or, better still, we want to perform the queering of the virtuality/materiality binary through digital technologies.

Barad expresses this quantum superposition that cuts terms together and apart in the same moment by using the slash (/): this is crucial in Barad's thinking in order to divide and pull together pairs of terms such as non/being, in/determinacy, any/thing, non/existent, and im/possibility. What Barad means by the slash is more than just 'and' or rather 'or'; instead, the slash is entangling and differentiating in one move. This paper also examines the conceptual and artistic potential of virtual real-time collaboration and the ways in which collaborative virtual environments can be integrated into architectural and artistic design processes. This approach could generate positive effects on the development of novel artistic approaches by contributing to a more contemporary, location-independent, and ultimately more equal form of art production.

2 A NEW CONTEMPORARY FIELD OF ART

We are about to witness the emergence of a new contemporary field of art that collaboratively includes a new form of audience: visitors turn into collaborators in projects that have the tendency to go viral, usually initiated by online mass media platforms.[4] Reddit r/place, a 72-hour-long collaborative social network experiment that was hosted by the social networking site Reddit in 2017, can be regarded as an example of this: a Reddit subsite provided a digital canvas for collaborative pixel art, on which players could change the colour of a pixel every 5 minutes.[5] Reddit r/place started from a blank page. Signs, symbols, flags, and even more complex drawings emerged out of nothing, only through the interplay of a multitude of agencies. These fluctuating pixels, popping in and out of existence,[6] embody a never-ending dynamism of indeterminacy. Another example is Moon, a collaboration between the artists Ai Weiwei and Olafur Eliasson. Moon gives an insight into the potential of multi-agent environments. It was based on a web platform where participants from all around the globe could collaboratively draw and thereby connect.[2] The online visitors were welcomed to actively help shape a digital moon surface, initially white and empty, by scribbling on it or leaving a remark in text. The digitally created collaborative platform defined a space beyond national borders and let the participants connect and exchange in a remote but inventive and vivid manner (Link). The platform welcomed contributions from November 2013 to September 2017; in this period, over 80,000 entries were made, transforming the empty, digital canvas of the moon into a collaborative online space featuring drawings, remarks, and conversations. Moon underlines those online environments building on collaboration may go beyond what is defined as a game. It blurs the distinction between online social environments and online gaming environments and ultimately makes art out of the practice of contributing playfully to a collaborative piece.

Both Reddit r/place and Moon are platforms that allow for a collaborative process filled with conversations and intra-actions performed by an online crowd. From an architectural perspective, we argue, both platforms cannot be considered just an online medium – they are highly spatial. We will furthermore use Barad's theories to elaborate on the spatial qualities embedded in these collaborative artworks.

[2] accessible on moonmoonmoonmoon.com from 2013-2017

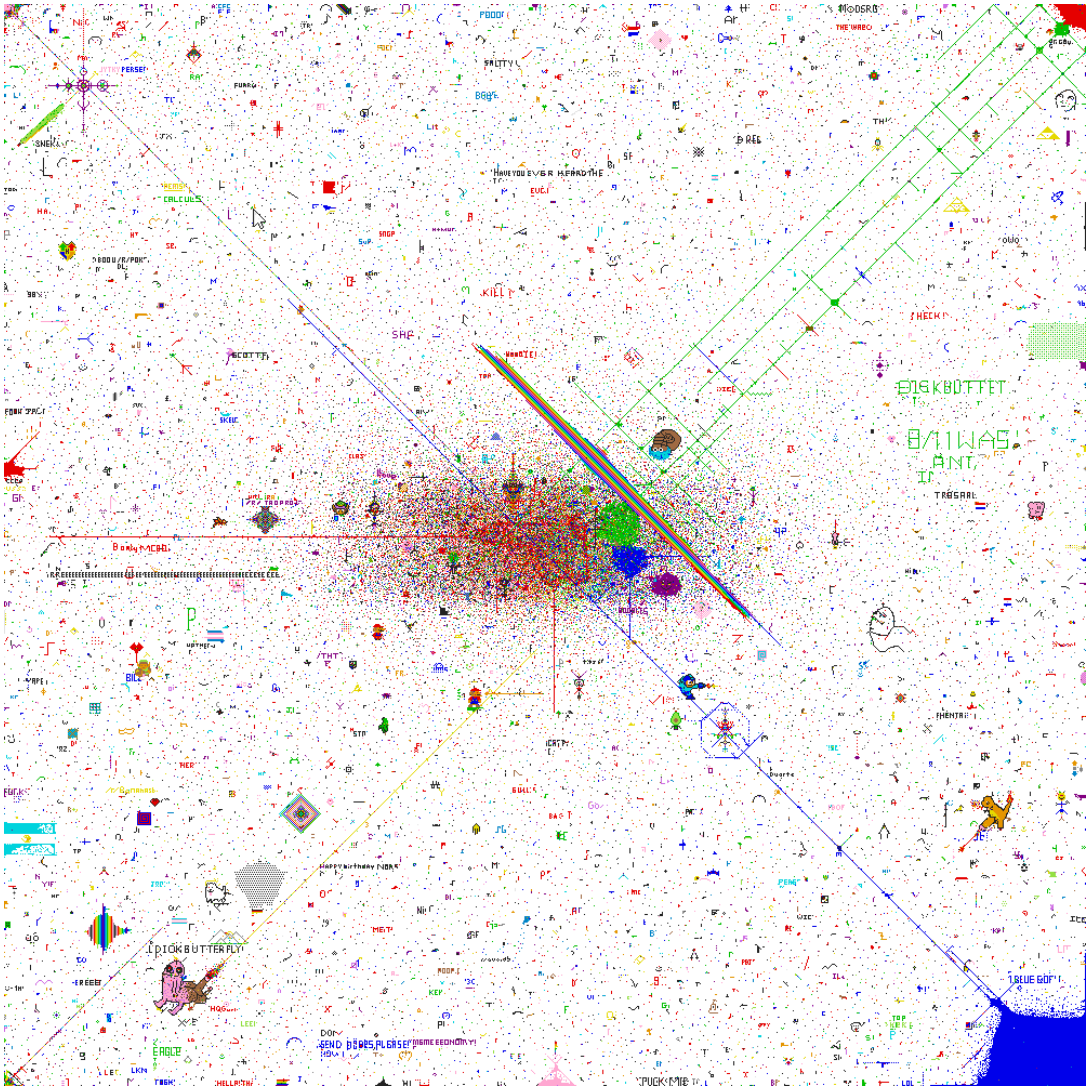

Figure 1: r/place

3 AGENTIAL REALISM – KAREN BARAD

An excursus into Barad's agential realism will shed light on the educational potential of the newly emerged online collaborative spaces. In the essay *What is the measure of nothingness? Infinity, virtuality, justice*,[7] Barad approaches nothingness through the lens of quantum field theory. They[3] introduce a set of concepts (measurement, intra-action, in/determinacy, vacuum fluctuations, virtual particles, and in/finity) which lead to the final conclusion that 'nothingness is not (a form of) absence but an infinitive platitude of openness'.[8] Barad begins with the difficulties of measuring nothingness. They point out that measurements are performative as 'they help to constitute and are a constitutive part of what is being measured. […] measurements are intra-actions'. Intra-actions substantially differ from interactions, as they inseparably entangle the observer with the observed and thereby deconstruct the binary between subject and object. Barad states that 'Measurements are world-making: matter and meaning do not pre-exist, but rather are co-constituted via measurement intra-actions.'[9] Their account thus dismisses and deconstructs classical ontology and proposes instead the notion of 'inherent ontological indeterminacy'[10] at the heart of quantum field theory. Ontological 'in/determinacy is [...] an unending dynamism'. It is the condition for the possibility of all

[3] Barad uses 'they' as a pronoun, a practice we will follow throughout the paper when describing Barad

structures which are unstable and constantly reconfiguring. In other words, it is 'the condition of im/possibilities'[11] and 'an un/doing of identity that unsettles the very foundations of non/being'.[12]

In quantized fields, not everything is possible but it is important to understand that nevertheless there are infinite possibilities. Therefore, a vacuum is not to be considered empty, even if nothing measurable seems to be in it. This also means that a particle is not just made up of itself, on the contrary, it includes a myriad of indeterminate virtual particles. Science journalist Stephen Battersby expounds on the existence of these virtual particles in his article *It is confirmed. Matter is merely vacuum fluctuations*: 'Each proton (or neutron) is made of three quarks – but the individual masses of these quarks only add up to about 1% of the proton's mass. So, what accounts for the rest of it?'[13]

It follows that even 'the smallest bits of matter are' already 'an enormous multitude',[14] and, following Barad, we may conclude that matter is never settled. As stated above, matter is always radically open. Barad states, 'Infinity and nothingness are infinitely threatened by one another so that every infinitesimal bit of one always already contains the other.'[15] Infinities, beyond serving as mathematical assets, are the incarnations of all possibilities. They are 'incarnated marks of in/determinacy'. Or, put differently, 'infinity is the continuously ongoing material reconfiguration of nothingness'.[16]

Following Barad, it may be concluded that both Reddit r/place and Moon start from so-called nothingness, not to be considered an emptiness but rather a radically open canvas ready to receive entries that intra-act or build relationships. The building of relations between the human and the non-human is the fundamental notion of Barad's agential realism. For Barad, phenomena or objects do not exist, as such. Anteceding their interaction, on the contrary, they pop into existence via bespoken intra-action. Thus, the contributions made by online visitors of Reddit r/place are not to be viewed as objects; rather, they emerge from contributors performing intra-actions. Commenting on the Moon collaboration, Olafur Eliasson posits that 'Each contribution has created a small but distinctive change to a developing landscape – highlighting the importance of individual expression amongst collective participation. Moon's open call for creative input is a powerful statement about the potential for ideas to connect people across vast distances and breakthrough political, social, and geographical boundaries in the Internet age.'[17] Eliasson's explanation alludes to the need for joint and purposeful manners to overcome borders across nations and within societies while creating spaces as well as opportunities for human and non-human entities to intra-act. His statement also expresses the extent to which the Internet, including its online shared environments, affects the production of art.

In the article *Virus, Viralität, Virtualität (Virus, Virality, Virtuality)*,[18] published in 2020 regarding the pandemic, artist and media theorist Peter Weibel makes clear that we currently live in a long-distance society based on digital technology rather than in a local society. He states that the pandemic caused by the Covid-19 virus sheds light on the fragility of the so-called close society in which we are physically close to one another; in need of a host, the virus spreads from body to body. For more than 100 years now, the invention of various telecommunication technologies has meant that people have not always needed to be physically near each other to communicate, resulting in an irreversible separation of messenger and message.[19]

An underlying tone in Weibel's words suggests that the state of contemporary online togetherness, in particular the ways in which we deal with and refer to one another, is in need of critical assessment. Therefore, in this paper, we will look further into notions of building identity.

4 PERFORMATIVE AND POSTHUMAN IDENTITY

Looking again at Reddit r/place or Moon, it becomes evident that the online crowd of individuals characterize themselves via their real-time contributions – their performance. In performing their contributions to the environments, they overcome usual stigmata, such as nationality, gender, or age.

A major contribution to the notion of the performative can be found in Judith Butler's essay from 1988, *Performative acts and gender constitution: An essay in phenomenology and feminist theory*, in which she

introduces the concept of the performative into cultural philosophy: her notion of the performative is not primarily focused on the 'success/failure' criterion of a performed action; rather, Butler emphasizes phenomenal conditions of embodiment. [20] She writes, 'The body is […] a continual and incessant materializing of possibilities. One is not simply a body, but in some very key sense, one does one's body, and, indeed, one does one's body differently from one's contemporaries and from one's embodied predecessors and successors as well.'[21] A body's individual materiality is the result of a repetition of gestures and movements. These actions mark a body as an individual of a certain gender, ethnicity, and culture. This means identity is constituted by performative acts – identity being a bodily and social reality. For Butler, performative acts are constitutive of reality, and most importantly, they are non-referential.[22] She states, 'an identity [is] instituted through a stylized repetition of acts.'[23] An identity, therefore, does not refer to something ontologically or biologically given, to something inside of the body, to a substance, or to a being that needs to be expressed. Fixed identities do not exist. Identities are neither stable nor given, they are performed and thus open. Following Butler, the body is 'an active process of embodying certain cultural and historical possibilities'.[24] For her, the process of embodiment is a process of performative creation of identity.

The realization that users, who are connected in online collective environments, perform a notion of identity in the way Butler suggests is derived from a critical investigation of a multiplayer experiment, which was already extensively discussed in a separate paper written by one of the authors (Valerie Messini) together with co-author Damjan Minovski for the Smart Art Conference in Belgrade earlier this year: *CYBER SANDBOX – An experiment on collaborative sketching in shared virtual space.*[25] The multiplayer experiment *safari (zaˈfaːri) سفر A Multiplayer Exploration* took place within the framework of a seminar for Master's students at ./studio3 – Institute for experimental architecture, under the lead of Professor Kathrin Aste at the University of Innsbruck, Austria and taught by Valerie Messini, Damjan Minovski, Dominic Schwab, and Dominik Strzelec during the winter term 2019–2020. The environment involved 50 students who collaborated in real-time via a Unity application programmed specifically for the experiment. Without being able to communicate verbally, the 50 students had to build 3d models of, for example, an elephant in a limited time frame of no more than 15 minutes. In order to act, each student had their own (3–5 different) premodelled geometries – rotatable and scalable – to distribute, and they were entitled to delete whatever they liked. The results were remarkable: we could see how intuitive and spontaneous actions ultimately generated a highly speculative and fragile form of spatial and material organization and how collaborative environments guided the players towards a form of non-hierarchical cooperative artistic production, in which individual tasks were not given beforehand but emerged from the collaborative process itself.

Figure 2: Safari - Experiment 1: Elefant

The digital collaborative space is not only supposedly post-ethnicity and post-gender, as only the interaction with others defines the players' identity (via enacted actions of placing or deleting, in this case), but it is also a multiverse of democratic collaboration, where constant creation, ruthless destruction, and never-ending collective inspiration are extinguishing binaries, such as the binary categorization of a good versus a bad action.

5 CONCLUSION

Working in a collaborative real-time environment does enact a critical conception in Barad's sense of 'agential realism', where meaning and knowledge are created only as per intra-action. We can suddenly imagine new forms of collaboration emerging from being together virtually, performing a digital real-time identity that is post-gender and post-ethnicity.

Employing collaborative online environments, such as *safari*, beyond their aesthetically appealing outcomes offers an enormous potential to convey to a student audience the importance of critically assessing the ways in which identity is performed and built. Students may become aware of their own existing biases towards origin and ideals regarding the notion of humans and eventually deconstruct these biases by enacting (infinitely) open human identities. Working within such an online multi-agent environment allows for an empirical understanding of the posthuman condition and thereby generates awareness for the limitations of 'humanistic, anthropocentric and dualistic assumptions' of the Western humanist philosophical discourse.[26]

To conclude, Barad's theory of agential realism proves fruitful and versatile when read against collaborative setups stemming from the art scene, so that pivotal aspects regarding the notion of relation-building may be distilled: as she draws the attention to the intra, the in-between of an interaction, the boundaries between the artist who is doing the designing and what they design are blurred.

As our present is characterized by instability, uncertainty, complexity, and ambiguity, the way we live, learn, work, and socialize will profoundly change. New forms of individual and collective agency are required as well as interactive and hybrid types of space.

6 ACKNOWLEDGEMENTS

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Fig [1] r/placecc; (CC0 1.0) https://static.im-a-puzzle.com/gallery/Animated/reddit_the_place.gif
Fig.[2] Safari - Experiment 1: Elefant © Valerie Messini, Damjan Minovski 2021

HOW ARTIFICIAL INTELLIGENCE WILL SHAPE UNIVERSITIES OF TOMORROW

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Abstract. *Even though the digital transformation of higher education institutions has been accelerated by the COVID-19 pandemic, the digitisation of teaching and learning is an ongoing challenge. The use of artificial intelligence (AI) methods in higher education is promising in many ways. This paper explores the possibilities of implementing AI in university processes and presents its concrete implications for the future of education. To this end, the existing scientific literature on the topic is reviewed. According to experts, AI is expected to provide opportunities for the universities of tomorrow by reshaping their ways of teaching and operating: teachers and supporting staff can focus their attention and time on the needs of their students, allowing them to reach their full potential by personalising and monitoring their learning based on their interests. Finally, this paper discusses the challenges and limitations of AI in teaching and learning, focussing on the issues of access and equity, and provides some preliminary answers to the question of how AI can enhance human interaction rather than diminish it.*

Keywords: Artificial Intelligence, Education, AIEd, Innovation, Global, Digitised

1 INTRODUCTION

In recent years the use of digital technology, and artificial intelligence (AI) in particular, has changed almost every aspect of our lives and will continue to do so. With AI already being part of our daily activities, often without us realising it, experts believe it will revolutionise the way we communicate, teach, and learn. When it comes to higher education institutions, AI is expected to play a pivotal role in enhancing teaching and learning, and in finding solutions to address the educational challenges of tomorrow.

In the context of the paper at hand, AI is defined as an umbrella term for computer systems that can perform tasks that typically require human intervention. Two characteristics distinguish it from traditional software. First, the ability to perform complex tasks without constant guidance, and second, the ability to self-update and improve its performance with new input [1].

There are several ways in which AI can be structurally implemented in the higher education landscape. It can help teachers and learners by tailoring the learning content and method to the individual student's abilities and needs, promoting the development of future skills, and allowing for life-long learning. By drastically automating routine tasks, teachers will be able to reduce their workload and focus their attention on their students and research. Smart campus management platforms can facilitate the governance of higher education institutions by monitoring enrolment, attendance, and by providing virtual assistants as a focal point for information [2].

2 OPPORTUNITIES OF AI IN EDUCATION

2.1 EMPOWERED TEACHING AND LEARNING

Teaching methods that make use of predictive analytics and machine learning have the potential to provide students with personalised learning experiences. Research shows that teaching is most effective when it is tailored to the specific background of students and their context [3]. In contemporary education, teachers cannot always take into account their student's prior knowledge, emotional state, or economic background.

AI can play an important role here, as it can store this information for each student, adjusting the teaching approach to the student's specific needs. It can do this, for instance, through Adaptive Learning Platforms (ALP). ALP allows for learning anywhere, anytime, address the learner's abilities and needs and enable them to learn at their own pace. This especially benefits those with learning difficulties, thereby improving access to education [2]. One component of ALP is the use of Intelligent Tutoring Systems, which help reflect and reassess an individual's approach to learning. This means that learners gain more insights into their preferred learning techniques and learn most efficiently , taking into account their strengths, weaknesses, and challenges [3].

Unlike teachers, AI systems can collect vast amounts of data from their students and identify their individual learning patterns and knowledge gaps. Such data provides teachers with new insights into their students' progress, needs, and abilities, allowing them to develop content and methods that are most beneficial to them. The automation of routine tasks allows teachers to focus on non-routine work, provide individualised support, and prepare new instructional approaches [3].

Furthermore, AI is likely to change the current assessment methods. With AI-powered assessment tools, learners benefit from personalised and immediate feedback. Compared to standardised exams and tests, AI-based assessment tools provide fairer feedback that has more value to the learner than a mere grade, because the tailored suggestions for improvement helps learners understand their progress[3]. It is important to note that AI assessment tools can only reduce inconsistencies to a certain extent, as their effectiveness depends on the quality of the data they are fed. If the data is biased, the AI-based assessment tool will also be biased.

2.2 FUTURE SKILLS AND LIFE-LONG LEARNING

Aside from improving teaching methods, the introduction of AI in education is also expected to provide learners with the necessary technical skills for their future careers. Acquiring technical skills is critical as it enables future employees to cope with a labour world that will become highly dependent on technology[4]. Learners' exposure to AI-driven tools helps them acquire skills such as digital literacy, data literacy, virtual collaboration, and resilience to change[2].

At the same time, an ever-changing working environment and the demographic shift will require future professionals to be adaptive, meaning that learning will not only take place within the walls of educational institutions. Improved access to Massive Open Online Courses (MOOCs) will allow for life-long learning independent of age, financial background, geographical location, and educational level. Studies suggest that current MOOCs lack personalised guidance, do not adequately map individual progress, and are not easily accessible to students with disabilities[5]. This is where AI can play a role since it has the potential to enhance the learning experience in MOOCS and identify areas where human interaction is needed[6].

3 REALISING THE OPPORTUNITIES OF AI IN EDUCATION

In order to realise the opportunities that AI creates, a digital transformation of the educational model of higher education institutions needs to take place. This requires more than just digitising the current model, it requires changing the pedagogical approach.

To this end, universities will need to shift their focus from knowledge transfer to problem-based learning (PBL)[2]. Currently, universities often teach in the form of lectures, whereby information mainly flows from professor to students and is evaluated by means of examinations. PBL entails a learner-centred approach, which empowers students to apply their skills to a real-world problem related to the course content[7]. By shifting towards PBL, future employees are prepared to work hand-in-hand with AI, meaning that they will be hired for their ability to apply knowledge to real-world problems, rather than just for possessing it.

In addition, emphasis should be placed on strengthening skills unique to humans, such as soft skills, critical thinking, and moral character, as well as the ability to work together in an interdisciplinary and international

team. These represent some of the core competencies needed in the globalised workplace of the 21st centuryand are what set human employees apart from AI[8].

Transforming the current pedagogical model to one that uses digital tools and AI in appropriate and efficient ways is a lengthy process. A framework that illustrates how technology-driven change is facilitated is the Three Horizon framework (see Figure 1). The three horizons illustrate the short-, mid-and long-term stages of technology-driven innovations. The framework focuses on the challenges current systems face, what innovative future systems might look like and which domains of policy and practice need to change in order to create new, disruptive patterns[9].

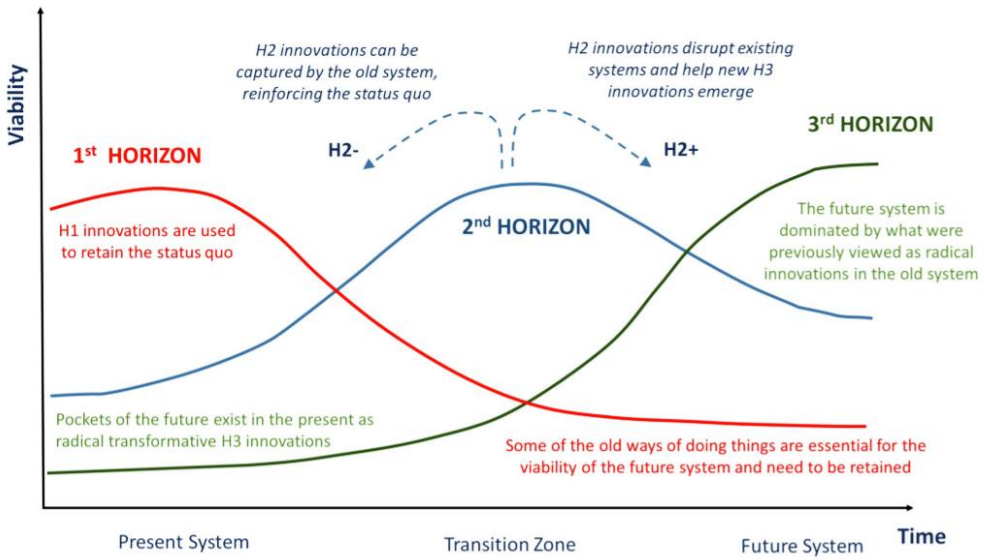

Figure 1: Three Horizon framework. From "Transforming knowledge systems for life on Earth: visions of future systems and how to get there.", by Fazey et al., 2020.

External factors cause the three overlapping horizons to fluctuate in their viability. As such, processes of the first horizon naturally become obsolete over time and disruptive innovations of the second horizon lead the way to new, emerging patterns of the third horizon. For example, according to this model, technological advances in education will eventually replace the old way of teaching and new, AI-powered ways of teaching will become the new normal. The future higher education system will most likely be dominated by innovations that are currently considered to be radical[9].

4 CHALLENGES AND ETHICAL QUESTIONS

One significant challenge of incorporating AI into learning and teaching is doing it in an accessible way, without creating barriers for those who are less digitally savvy or do not have the necessary equipment. In particular, the acquisition of AI competencies should be possible for all so that this does not become a privilege for the lucky few. These factors must be considered when developing AI-based learning tools and providing licenses to use them .

Digital illiteracy among teachers, especially those who have not grown up with new technologies, might pose another problem. To manage and use digital tools and AI in education effectively, teachers need to be able to understand the data and functions provided, so basic analytical skills should be ensured [3].

The collection of data needs to be governed by ethical regulations, concerning for instance the type of data that is collected, who has access to it, and how it can be protected from exploitation. In this context, a common framework, such as the *OECD AI Policy Observatory* [10], could guide the governance of AI technologies.

Finally, depending on the heterogeneity of the data used to develop and train them, machine learning algorithms are susceptible to biases that may result in unfair treatment of certain groups. This risk must be considered and closely monitored when designing and validating the tools.

5 CONCLUSIONS

In a labour world with increasingly rapid technological change, universities will continue to play a central role in preparing graduates for the future. However, change is not only created by technology, but also by a shift in pedagogical models. As AI impacts the way we teach and learn, both learners and teachers will be empowered by insights into unique learning pathways and knowledge gaps. Rather than being rendered obsolete by the use of AI in the classroom, the role of the teacher will continue to be that of the final decision maker, now able to make even more informed decisions[3]. To ensure that the use of AI tools will not become a burden or barrier to anyone, those who will ultimately use these tools must be involved in their design and development. By offering support to teachers and learners, AI has the potential to enhance human interaction and allow us to focus on qualities that are uniquely human, such as creativity, empathy, and our consciousness, qualities that AI cannot replicate anytime soon.

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EDUCATING TOMORROW'S WORKFORCE FOR THE FOURTH INDUSTRIAL REVOLUTION – THE NECESSARY BREAKTHROUGH IN MINDSET AND CULTURE OF THE ENGINEERING PROFESSION

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Abstract. *We are calling for a paradigm shift in engineering education. In times of the Fourth Industrial Revolution ("4IR"), disruptive changes affect all industrial sectors and society, leading to increased uncertainty that makes it impossible to predict what lies ahead of us. Thus, incremental culture change in education is not an option anymore. The vast majority of engineering education and training systems, having remained mostly static and underinvested for decades, are inadequate for the new 4IR labour markets. Some positive developments in changing the direction of the engineering education sector can be observed. Novel approaches of engineering education already deliver distinctive, student-centred curricular experiences within an integrated and unified educational system. We must educate engineering students for a future whose main characteristics are volatility, uncertainty, complexity, and ambiguity (VUCA). Talent and skill gaps across all industries are expected to grow in the years to come. The authors promote an engineering curriculum that combines timeless didactic tradition, such as Socratic inquiry, project-based learning, and first-principles thinking with novel elements (e.g., student-centred active-, and E-Learning by focusing on case studies) as well as a refocused engineering skillset and knowledge. These capabilities reinforce engineering students' perceptions of the world and the subsequent decisions they make. This 4IR engineering curriculum will prepare engineering students to become curious engineers and excellent communicators navigating increasingly complex multistakeholder ecosystems.*

Keywords: engineering education; Fourth Industrial Revolution; 4IR; Artificial Intelligence; A.I.; skills gap; future of work; E-Learning; didactics

1 INTRODUCTION AND BACKGROUND

Humankind in the 21st century is faced with numerous global challenges and risks [1], such as failure of climate-change mitigation and adaptation, extreme weather, human environmental damage, infectious diseases, biodiversity loss, natural resource crises, failure or increasing cyber vulnerability of critical infrastructure, water crises and failure of long-term strategic infrastructure and urban planning. The engineering profession needs to bear these challenges and take on more responsibility [2,3]. A business-as-usual attitude in the face of such substantial challenges will not be the responsible course of action. The fourteen Grand Challenges for Engineering in the 21st century (Figure 1) developed by the U.S. National Academy of Engineering [4] can be used as a guideline for future-ready universities to design curricula and identify impactful research areas. Foremost among the challenges are those that must be met to ensure the future itself. According to [4], the Earth is a planet of finite resources, and its growing population currently consumes them at a rate that cannot be sustained. Widely reported warnings have emphasized the need to develop new sources of energy while preventing or reversing the degradation of the environment.

When asked the top three most critical areas of transformation in civil engineering, during the World Economic Forum's Annual Meeting 2018 [5], Chief Executive Officers of the construction industry prioritized the key areas as follows: Attracting new talent and building up required skills, integrating and collaborating across the value chain and adopting advanced technologies on a large scale (see survey results summarized in Figure 2).

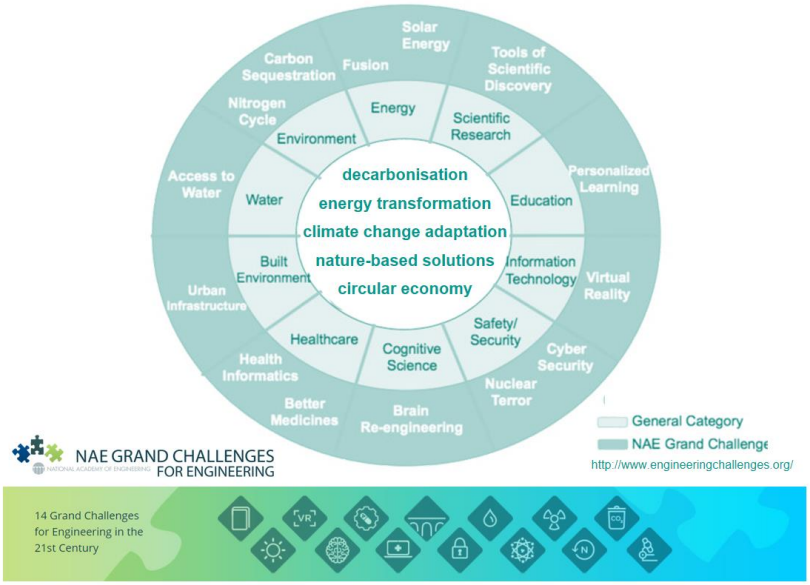

Figure 2: The fourteen Grand Challenges for Engineering in the 21st century developed by the U.S. National Academy of Engineering can be used as a guideline for future-ready universities to design curricula and identify areas of research

Similarly, during the Annual Summit of McKinsey's Global Infrastructure Initiative [6] in the fall of 2018, construction executives were asked what the most significant challenges will be for project leaders in the next decade: Developing a culture of innovation that embraces disruptive technologies, attracting and retaining the right talent, moving to more collaborative, less adversarial contractual arrangements and developing a more diverse and inclusive workforce were the topmost challenges identified.

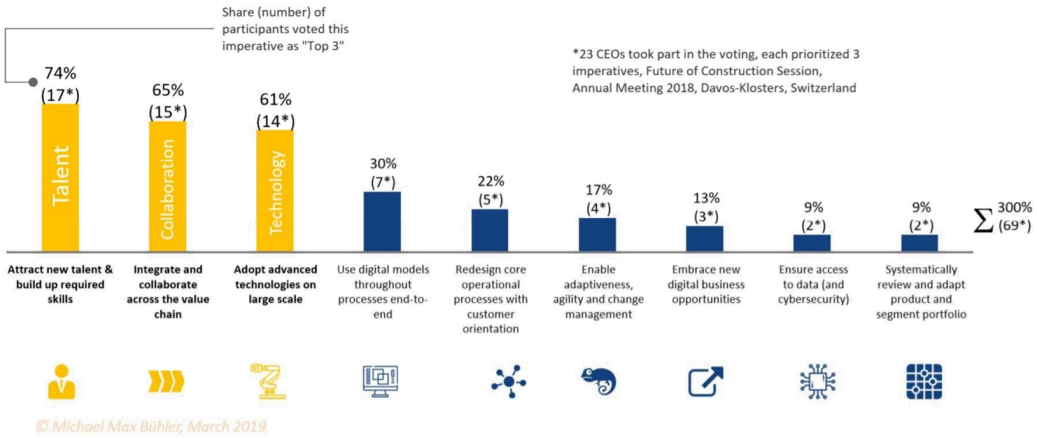

Figure 3: When asked the top three most critical areas of transformation in civil engineering, during the World Economic Forum's Annual Meeting 2018, Chief Executive Officers of the construction industry prioritized the key areas as follows: Attracting new talent and building up required skills, integrating and collaborating across the value chain and adopting advanced technologies on a large scale

2 PREPARING FOR THE 4TH INDUSTRIAL REVOLUTION

We cannot ignore that we have already arrived amid the next industrial revolution that fundamentally transforms our economies, societies, and even who we are as human beings. Thinking and acting around this Fourth Industrial Revolution (4IR) [7] – which is characterized by a range of new technologies [8] that are fusing the physical, digital and biological worlds – demand that we acquire new skills and a new style of leadership [9]. With these deep-seated changes impacting us, educational requirements for the engineering profession will be heavily in flux [10]. To successfully meet the environmental, societal, and financial challenges of an increasingly complex and hyper-connected world, we must get together to rethink and reinvent our profession. Hence, we must ask ourselves how we can create a more integral engineering curriculum that will anticipate industrial disruption and sufficiently prepare our young and established civil engineers for the future. The 4IR demands that the engineering profession renews itself continuously, better promotes its accomplishments, and cultivates a future generation of engineers. This next generation of engineers must be well equipped

- to contribute to society,
- lead and shape global issues,
- identify and solve technical problems, and
- find, articulate, and pursue the societal opportunities of tomorrow.

According to [10], the exponential rate of technological change requires an urgently needed education transformation. Education systems need to undergo transformative change to ensure inclusive and sustainable development for all, not just for the privileged few. We face fundamental ethical questions about harnessing the knowledge and skills we possess to create new products and opportunities. Adopting novel and more effective models of education to meet talent demand will shorten the period of "social pain" and maximize the period of "prosperity" for all (see the development of education versus development of technology over time in Figure 3).

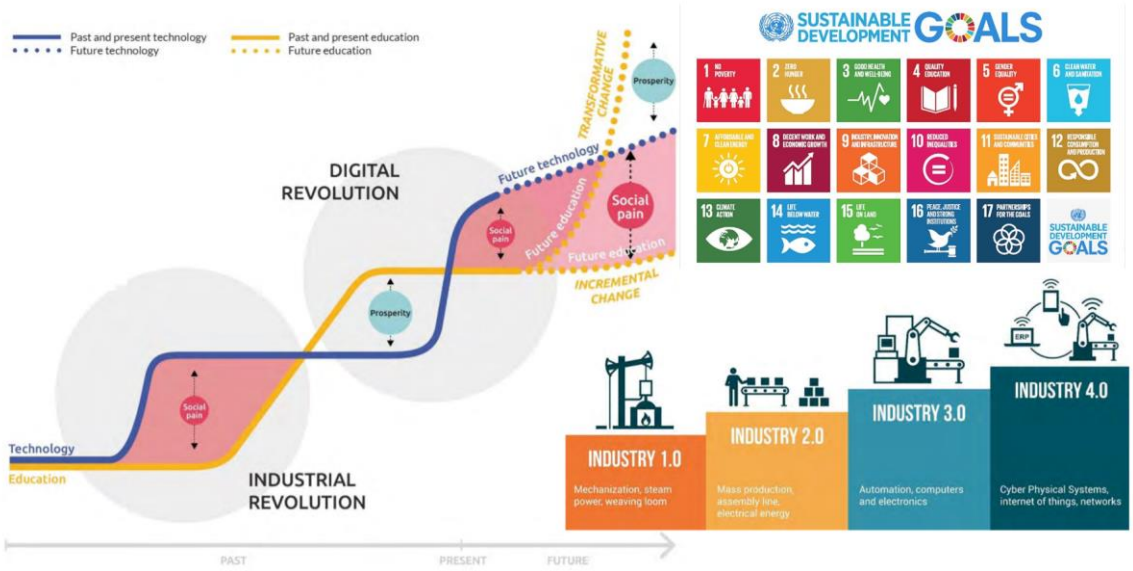

Figure 4: The race between technology and education as depicted by Goldin and Katz (2010). The authors of this paper believe that education might fail to catch up with the accelerated rate of technological change in the years to come. However, the exponential technologies of the Fourth Industrial Revolution (4IR) will support humanity to meet the United Nations' Sustainable Development Goals. Adopted and modified diagram after McLellan (2018, ref), Goldin and Katz (2010, [10]) and United Nations S.D.G. [11].

3 FUTURE-PROOFING OUR EDUCATION SYSTEM

It is often stated that Artificial Intelligence ("A.I.") and automation are competing against humans. However, this is only true in a small but likely impactful field of human intelligence [17]. Due to technical developments repetitive human skills have been continuously replaced by machines. This process is now certainly pushed forward by A.I. and automation and challenges repetitive knowledge work. This does not replace us as human beings, rather it uncages the potential of developing stronger internal human competencies [18]. Three capabilities where A.I. is falling short in the short and medium term have been identified recently [12]. Humans' most significant differentiators from Artificial Intelligence are creativity, dexterity, and empathy:

- CREATIVITY: A.I. cannot create, conceptualize, or plan strategically. While A.I. is great at optimizing for a narrow objective, it cannot choose its own goals or think creatively. Nor can A.I. think across domains or apply common sense.
- EMPATHY: A.I. cannot feel or interact with feelings like empathy and compassion. Therefore, A.I. cannot make another person feel understood and cared for. Even if A.I. improves in this area, it will be challenging to get the technology to a place where humans feel comfortable interacting with robots in situations that call for care and empathy, or what we might call "human-touch services."
- DEXTERITY: A.I. and robotics cannot accomplish complex physical work that requires dexterity or precise hand-eye coordination. A.I. can't deal with unknown and unstructured spaces, especially ones that it hasn't observed.

The list of such internal competencies of human beings can be strongly amended, e.g. like self-consciousness, intention, purpose, and spirituality on the individual level and culture, morality community values on

the collective level, just to give some examples. Such development will support humans to grow in fields of competencies that differentiates humans from machines.

Figure 4 is adopted from [12] and depicts typical physical jobs on a dimension between mechanical and dexterous, i.e., skillful manual work. Mechanical jobs will be automated in the future and will be replaced by A.I.-supported machines. Cognitive jobs can be seen on a scale between routine processing and creative generation. A.I. algorithms will replace routine jobs, e.g. chatbots. The upper right back diagonal in Figure 4 favours humans, and the lower left front diagonal favours A.I.

As a consequence, in education, a business-as-usual attitude will ultimately lead to irrelevancy. Therefore, a refocusing of the universities will be required to move their teaching staff into the social-dexterous-creative quadrant, as explained in Figure 4.

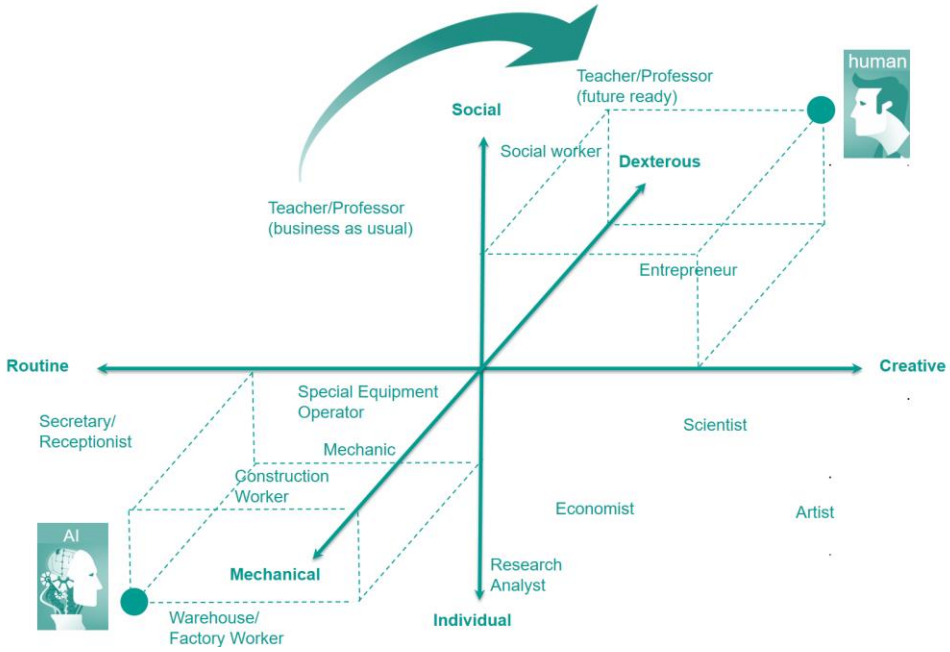

Figure 5: Physical jobs are differentiated between mechanical and dexterous. Mechanical jobs will be automated in the future and will be replaced by A.I.-supported machines. Cognitive jobs are differentiated between routine processing and creative generation. Routine jobs will be replaced by A.I. algorithms, e.g. bots. The upper right back diagonal favours humans, and the lower left front diagonal favours A.I. Dimensions adopted from [12]

4 THE NECESSARY TRANSFORMATION OF THE WORKFORCE

To train hybrid intelligence systems, socio-technological ensembles of humans and machines [13], universities will need to redesign curricular, whereas the government has to incentivize skills required instead of providing universal basic income. To transform the human workforce to deal with the A.I. economic revolution [14], we will have to relearn new skills related to strategy, creativity, empathy-based social skills, and dexterity. In addition, educators will need to prepare the workforce by recalibrating new jobs towards human-A.I. collaboration. There are significant opportunities to reinvent many jobs and create new ones through a more profound interdependence between A.I. optimizations and "human touch." According to [12], a renaissance led by A.I. will enable and celebrate creativity, compassion, and humanity; In this new era, people will follow their passions, creativity, and talents once they have more freedom and time. A.I. tools will reinvent education, giving teachers A.I. tools to help students find their passions and talents. Education will encourage curiosity, critical thinking, and creativity. It will promote learning by doing and group activities that enhance students' emotional intelligence.

The authors think that such a competence transformation will not only lead to the development of "inner" competencies of humans, it will also lead to a new level of "outer" competencies, which already had been addressed elsewhere [16].

5 A BREAKTHROUGH IN EDUCATION

According to Sir Ken Robinson [14], "*we have to transform what is essentially an industrial model of education, a manufacturing model, which is based on linearity and conformity and batching people. [For the university of the future], we have to move to a model based more on principles of agriculture. We have to recognize that human flourishing is not a mechanical process–it's an organic process. And you cannot predict the outcome of human development. All you can do, like a farmer, is create the conditions under which they will begin to flourish*".

As a consequence, the current one-size-fits-all education system has to acknowledge that each student is different. Therefore, A.I.-infused schools will perhaps hold the most significant opportunity for A.I. in education, which is individualized learning. A personalized A.I. tutor could be assigned to each student. Unlike human teachers, who must consider the whole class, a virtual teacher can pay special attention to each student. In the future, teachers will play two crucial roles:

First, they will be human mentors and connectors for the students. Human teachers will be the driving force behind stimulating the students' critical thinking, creativity, empathy, and teamwork. And the teacher will be a clarifier when a student is confused, a confronter when the student is complacent, and a comforter when the student is frustrated. In other words, teachers can focus less on the rote aspects of imparting knowledge and more on building emotional intelligence, creativity, character, values, and resilience in students. The second role that teachers will play is to direct and program the A.I. teacher and companion in ways that will best address the students' needs. They will do this based on their experience, wisdom, and in-depth understanding of the students' potential and dreams.

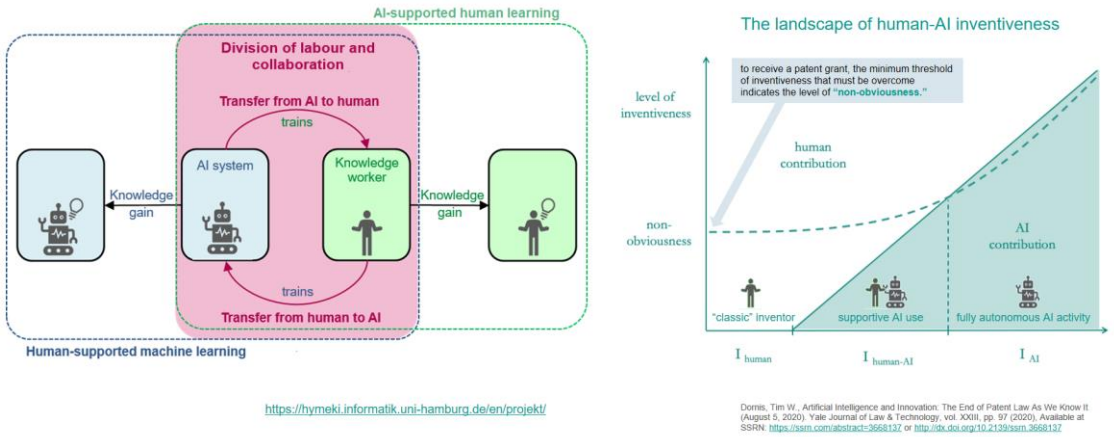

Figure 5: Human-A.I.-learning interaction

6 CONCLUSIONS

If we proceed business-as-usual, we will prolong the social pain, and thus teachers will be at risk. A.I. will enable effective personalized student learning and, therefore, will be essential to future university success. Teachers will be social facilitators but will also program A.I. The exponential technology combined with fundamental hard skills, including first principles thinking and soft skills such as empathy, creativity, communication, and collaboration, will play a key role in future-ready curricula.

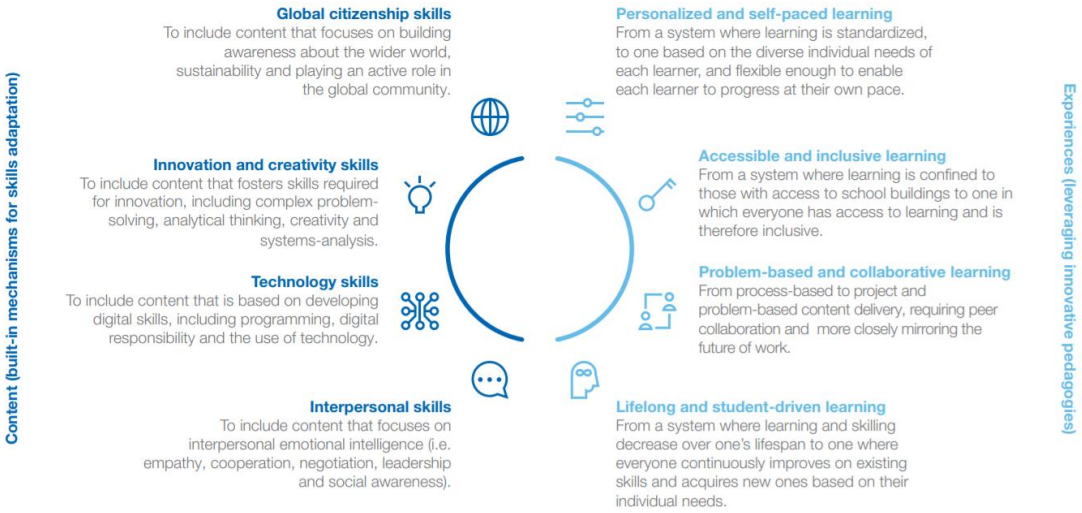

Figure 6: Education 4.0 – A Global Framework for Shifting Learning Content and Experiences Towards the Needs of the Future

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THE USE OF ECONOMIC EXPERIMENTS AS AN INTERDISCIPLINARY STRATEGY FOR TEACHING SUSTAINABILITY

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Abstract. *When reflecting on the skills and areas of competence essential for the future and how to teach them more adequately, we argue that the topic of cooperation for sustainability represents one of the pillars of this issue. This perspective demands changes in the way disciplines that address topics related to sustainability are taught. We propose a transition from traditional expository methods to more participatory methods, including economic experiments. Students, in the role of active participants in experiments that test theories, can overcome the purely theoretical field of expository classes and tend to recognize the possible dilemmas and outcomes of decisions that require cooperation for the preservation of the environment. The purpose of this study was to analyze how the public goods game can contribute to the teaching of sustainability and positively influence sustainable behavior. The experiment was applied to undergraduate business administration students, with punishment and reward treatments. The possibility of punishment proved to be ineffective, while the possibility of reward proved to be efficient. Then, students participated in focus group sessions, debating issues related to individual decisions, the determinants of cooperation, the role of other people's decisions, and the need to adopt sustainable behavior. Debates were stimulated about the attitude towards sustainability, the importance of good examples, the promotion of awareness campaigns, and the use of rewards. The long-term perspective as a justification for cooperation - especially when the individual gives up the value received to preserve the environment - represents one of the main learning points.*

Keywords: Economic experiments, sustainable behavior, sustainability education

1 INTRODUCTION

There is a consensus around the importance of sustainability, particularly by acknowledging the changes suffered by the environment over recent decades (Leiserowitz, 2005). However, such acknowledgment has not yet caused significant changes in the behavior of individuals. To mitigate this problem, more participatory and cooperative sustainability programs are suggested, as well as initiatives that can provide greater awareness of those involved (Meijers, & Stapel, 2011).

Sustainable behavior can be observed, for example, when individuals relinquish the present consumption to the benefit of future generations or abdicate their economic gains in order to preserve the environment (Soest; Stoop; Vyrastekova, 2016). Given this context, we need to envision the contributions of the behavioral economics games, in particular, of the public goods game, to the teaching of sustainability (Pickhardt, 2005). Students as active participants in experiments that test theories can overcome the purely theoretical field (Ball; Eckel; Rojas, 2006; Guest, 2015), acknowledging the possible dilemmas and results arising from processes that require cooperation to preserve the environment. Experiments conducted in the

classroom can bring numerous benefits, such as the promotion of social interaction, the positive impact on motivation and learning (Carter & Emerson, 2012; Guest, 2015), besides the growth of interest from the student's personal experience with the theories.

Public goods are non-excludable, which means everyone involved can enjoy its benefits, regardless of the contribution to its preservation. Considering that the preservation of the public good, as well as the environment, involves costs, the potential conflict between self-interest and collective interests is debated: even though mutual cooperation can bring greater benefits to a group, individuals have an incentive to take advantage of the contributions of others (Soest; Stoop; Vyrastekova, 2016). The purpose of this study was to analyze how the public goods game can contribute to the teaching of sustainability and positively influence sustainable behavior. Thus, we proposed experiments aimed at the preservation of a public good for undergraduate students in the city of Foz do Iguaçu (Brazil). This study is also an opportunity to research, once the preliminary review of the literature showed that few studies have addressed sustainability based on subsidies of experimental and behavioral economics, especially when directed to the teaching-learning domain. The issue of the interdisciplinary approach is also highlighted as a way of discussing and teaching sustainability promoting the interaction between the students, demonstrating the practical implications of the individual's decisions.

2 THEORETICAL BACKGROUND

2.1 ECONOMIC EXPERIMENTS ABOUT SUSTAINABILITY

To evaluate how the public goods game can contribute to the teaching of sustainability and positively influence sustainable behavior, we have to envision the contributions of an experiment in the classroom, related to environmental preservation, as a motivating mechanism for reflection and interactive learning (Carter & Emerson, 2012; Guest, 2015). As already verified in other disciplines, such as microeconomics (Emerson; Taylor, 2004), numerous authors have found improvement in the performance and learning of their students after the experiments (Guest, 2009), mainly as a complement to traditional teaching methods. Pickhardt (2005, p.157) states that "the active participation of the students, especially with respect to the agent's decision problems, will also create an interest for the theoretical explanation and is, in general, useful for the understanding of theories".

It is also recognized that the university and - especially - the teachers, assume an important role in promoting the involvement and engagement of their students in sustainability matters (Lehmann et al., 2009; Zilahy & Huisingh, 2009). For this, new teaching and communication standards in science and education are needed (Adomssent, 2013), such as the promotion of interactions between disciplines and between these and real issues of local society (Waas et al., 2010).

3 METHODOLOGY

The public goods game was adapted from Fehr and Gachter (2000). Eight experiments were carried out with groups of six to seven players each. Each round, players received two envelopes and 10 coins of $ 1 to choose how many coins they wanted to allocate in a '*public account created for the preservation of the public good*' (first envelope), and how many coins they wanted to allocate in their respective '*private accounts*' (second envelope). Unlike the allocation of coins to the individual account of each player, those donated to the preservation of the reservoir would be summed and then multiplied by two (representing the benefits of preserving it) and redistributed equally among the players. The experiment approached two possibilities of treatment: (i) letting the player punish the others and; (ii) letting the player reward the others:

After each experiment, participants answered a set of socioeconomic questions and participated in a focus group interview. The use of the technique of interviewing with focus groups has been used successfully in research that aims to verify the student's understanding of themes related to sustainability (Dlouhá & Burandt, 2015). Being a survey for educational purposes, the focus group addressed the interpretation of

students about (a) the decisions taken in the public goods game, (b) some of the determinants for the preservation of the reservoir, (c) the role of others' decisions and (d) the need to adopt sustainable behavior as individuals and as a group, with further reflection upon the practical applications of teaching sustainability, so that the students could understand the consequences of their decisions in the game, in their gains and the environment.

4 RESULTS

Observing the behavior of students during the application of the experiment, it was observed that donations for the preservation of the public good were higher when the group was submitted to treatment with the possibility of rewarding those who cooperated. Treatment with the possibility of punishing for lack of cooperation reduced the contributions. The average donations for the control rounds were 4.15; 2.81 for the punishable rounds; and 4.20 for the reward rounds. The amount available for each round was 10 pounds.

After the experiments ended, all eight groups went through a focus group session, conducted by the experimenter, lasting approximately 40 minutes each. The chart below summarizes the main results.

Table 1: Main results and learning themes from the focus group

Findings of the focus group after the experiment	**Theoretical discussions**	**Practical applications for the teaching of sustainability**
- The players' decisions were based on their gains in the previous round, while observing the gains of the others. They observed the amount the others had received, as well as the amount donated to themselves and to the preservation of the reservoir;	The proximity and access to information about the decisions of other players, as well as their respective gains, is a relevant variable, and so is the learning effect from previous rounds (Boosey, 2017).	The importance of 'good examples' and the dissemination of "the best practices related to sustainability" held by the organizations was approached in the classroom as mechanisms capable of changing the behavior of others regarding the preservation of the environment;
- players said they used their coins to punish someone when their allocation to the private account differed from the allocation of the others in the previous round; - The punishment would be a kind of "regulator" of allocations to the private account;	Conditional contributors are often willing to punish free riders, even when there is a cost, and such action does not confer long-term benefits (Gächter *et al*. 2008)	The tolerance to opportunistic behavior as a problem not only aimed at environmental issues was addressed, as well as the altruistic punishment as a very efficient mechanism to ensure the preservation of the public good. Environmental awareness as an alternative to punishment was also discussed.
- Some players said they decided to reward others to benefit/acknowledge those who gave more to the reservoir; - There is evidence of the following line of thought: "I'm not going to donate my money" to the reservoir, but I can reward who does.	Some of the reasons for reward included reciprocity (desire to repay the kindness of others) and aversion to the guilt of expecting donations from others (Dufwenberg, Gächter; Hennig-Schmidt, 2011)	Aspects were identified based on values and individual beliefs, which may influence the decision-making process regarding the environmental preservation
- In some groups it was suggested that, in case no one chose to preserve the reservoir, the government would do it;	The acknowledgment of how relevant would be the adoption of a sustainable behavior and its implementation, as well as the expansion of the worldview of individuals, pose challenges for	The need to expand the scope from individual interests to collective interests and the need to rethink the availability of resources for future generations was discussed

	environmental preservation (Meijers, & Stapel, 2011).	
- They acknowledged that the contribution to the Reservoir should occur even without punishment, which should be unnecessary for this purpose; - Even though they rewarded those who donated the most, they acknowledged that everyone should donate regardless of the reward, since they are direct beneficiaries of the reservoir	The observation showed a motivation for the contribution (though decreasing), and that it should not be linked to the application of penalties or rewards (Bowles; Reyes, 2012).	Acknowledgment that the preservation of the environment itself would be a motivation for the players to give up their coins, whose monitoring and use of financial incentives should be unnecessary; The application of penalties reduced the contributions, which we did not observe in the use of rewards.

Source: Prepared after the data collection

The game addressed the decision for environmental preservation as a dilemma so that all players would be in better condition if they donated their coins to a public good, from which all benefit directly or indirectly. However, after noticing the others, a player can get even more money taking the donations for him/herself. This finding was observed in the downward trajectory of the donations and the upward trajectory of the allocations to the private account.

Cooperation for the preservation, as a proxy of these donations, gives space to a selfish attitude, partly due to the free-rider behavior of some players. In this case, the possibility of being punished – on average – was not efficient to ensure donations to the public good, whereas the possibility of rewarding proved to be more efficient. In the focus group sessions, the students acknowledged that financial incentives should not be necessary, since everyone is responsible for the maintenance of the environment, as inhabitants of the region, although they have not adopted such attitude during the experiment. To reward those who cooperated more seems to be socially accepted behavior, predominant to the behavior of punishing those who do not cooperate.

Additionally, considering the multidisciplinary nature of the studies on sustainability, some analyses can be made concerning the behavior of students. First, the change of behavior throughout the process suggests that, although the sustainable behavior is the result of an early decision-making process, it is not a habit among the participants of the experiment. A habit implies that the rational action has already been automated by the individual, which, of course, was not shown in the results. The change of behavior throughout the experiment denotes a change in the logic used by the students regarding the decision-making process, which sets off different results (Schwanen, Banister, & Anable, 2012).

5 FINAL REMARKS

Individual decision-making fostered the debate on the posture towards sustainability and the relevance of good examples as influencers, as well as the importance of awareness-raising activities overlapping the punishments by the lack of cooperation for the preservation of the public good. The long-term perspective as justification for cooperation – especially when individuals give up the amount received to preserve the environment – represented one of the key learning points.

As a complementary approach to teaching sustainability, the public goods game encouraged the students' reflection upon the possibility to cooperate/contribute financially to the preservation of the environment or take advantage of its benefits from the contributions of others. The interaction caused by the debates (Carter & Emerson, 2012) during the focus groups addressed the possibilities of dealing with the theme from other theoretical perspectives, beyond behavioral economics and crowding out theory, since sustainability, while the teaching and research object, has multidisciplinary aspects (Waas et al., 2010).

The results of the experiments, especially regarding donations to the public good, agree with most studies with students available in the literature (Soest, Stoop & Vyrastekova, 2016). One of the contributions of this study was to discuss the cooperation in sustainability, encouraging students to reflect upon the impact of their individual decisions. The sustainability theme demands multidisciplinary discussions (Lehmann et al., 2009) and the use of alternative methods of communication in order to raise the debate and - consequently - the interest of students (Adomssent, 2013). Connections between theory, reality, and local issues of society represent possibilities for teaching this theme (Waas et al., 2010). By demanding that students make individual decisions and realize the impact of their choices on the preservation of the public good, on their earnings, and on the financial returns of the other participants in the experiment, the application of the public good game makes it possible to foster student reflection on their role promoting sustainability.

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HARD INFRASTRUCTURE AND SOFT FACTORS

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Abstract. *Sustainability criteria are increasingly becoming hard knock-out factors in terms of product responsibility, risk management, market competition. This applies on all scales, from (small) consumer products, utility services (water, energy, transportation) to large-scale infrastructure (airports, wind and solar parks, water dams, roads, and railways).*

We in the engineering community have a good tradition of teaching „the hard factors" like structural engineering, material sciences, physics, efficiency, and operations reliability. We engineers need to be world-class experts at that; who else should be able to make a dam safe, and an airport commissioned on time? Current and traditional university education is highly cognisant of this; thus we educate and train our students accordingly.

However, additional skills are required for tomorrow's engineers in the field of sustainability. While „the hard factors" remain critically important, the ability to deal with project-critical „soft factors" is increasingly required for planners in engineering bureaus and consultancies, regulators in communal and governmental offices, and for decision-makers about investments, and those who are seeking finance for projects; the positions in which the engineers we are educating today will eventually grow into.

This paper lays out this situation with the example of the hydropower sector, which has just released an international Hydropower Sustainability Standard, in which the paradigm is underlined, that only engineering projects that perform across all dimensions of sustainability are acceptable in the future.

Keywords: Universities of Tomorrow, Sustainability, Sustainability Standards, Engineering Education

1 INTRODUCTION

Sustainability performance in engineering solutions is no longer merely a nice-to-have. Sustainability criteria are increasingly becoming hard knock-out factors in terms of product responsibility, risk management, market competition. This applies on all scales, from (small) consumer products, utility services (water, energy, transportation) to large-scale infrastructure (airports, wind and solar parks, water dams, roads, and railways). We in the engineering community have a good tradition of teaching „the hard factors" like structural engineering, material sciences, physics, efficiency, and operations reliability. We engineers need to be world-class experts at that; who else should be able to make a dam safe, and an airport commissioned on time? Current and traditional university education is highly cognisant of this, thus we educate and train our students accordingly.

However, additional skills are required for tomorrow's engineers in the complex field of sustainability. While „the hard factors" remain critically important, the ability to deal with project-critical „soft factors" is increasingly required for planners in engineering bureaus and consultancies, regulators in communal and governmental offices, and for decision-makers about investments, and those who are seeking finance for projects - all those positions in which the engineers we are educating today will eventually grow into.

And let me add a strong reminder that we are not only tackling our Climate Crisis. Interlinked is the planetary biodiversity loss and extinction crisis, and neither problem can be tackled in isolation.

And even beyond that, sustainability is a lot more. Since the definition by the Brundtland Commission in 1987, various industrial sectors are grappling with a proper and workable definition and good practice performance standards.

2 A SECTOR'S JOURNEY: HYDROPOWER

The hydropower sector has been complacent for too long. Having been the only renewable power generation technology able to deliver at scale for almost a century. Relying on a mature, cost-efficient, reliable, and trusted technology. Issues of social acceptance and environmental impacts were long considered "Somebody Else's Problems". Thus was the engineering education of the times.

However, those Somebody Else's Problems came back to haunt the sector. Hydropower became almost synonymous with the destruction of natural assets and biodiversity, for the physical and economic displacement of people, and for failing to deliver on commitments and promises. The sector became notorious for economically lost investments and stranded assets.

As planners, developers, regulators of such projects, these are not somebody else's problems. Those are our project's problems, thus making them our professional problems. Those problems can stall or sink our projects, our business, our credibility, our reputations.

The hydropower industry is responding to this situation. Hydropower is an important and needed technology in future energy systems. Furthermore, as energy systems are changing to renewables, pumped storage has many advantages to offer in a grid dominated by fluctuating electricity generation from wind and sun. So, as the first in the family of the various renewable power sources, the hydropower industry has given itself an ambitious code of conduct: the San José Declaration [1]. It is complemented with a stringent international Hydropower Sustainability Standard [2].

The San José Declaration says "the only acceptable hydropower is sustainable hydropower", and the Standard defines the criteria and the how-to of international good and best practices. Both were under hard work and tough negotiations for years. Now they are ready for use and were released in September 2021. This is the commitment that the International Hydropower Association (IHA) is presenting at the COP 26 in Glasgow.

The international Hydropower Sustainability Standard has 12 sustainability topics with 244 subtopics (criteria) in the project preparation life-cycle stage (there are 3 stages altogether: preparation, implementation, operation). Of these criteria, there are (depending on how you count) approximately 12% 'hard' engineering. This still leaves over 200 other („soft"?) criteria for a project to stumble over and possibly fail. Today's project developers and engineers must understand and operate in this complex reality.

3 SINK OR SWIM IN A CHANGING ENVIRONMENT?

There are many reasons for embedding sustainability performance in every aspect of developing projects and doing business. Reputation is one. Also, sustainability is a business case for gaining a competitive advantage over market competitors.

Avoiding, minimizing, and mitigating project risks is yet another one. Increasingly examples and systematic reviews and experiences demonstrate, how costly delays and the failure to obtain the social license to operate are threats to any project development, independent of the sector (e.g. [3][4][5]). Good sustainability performance in all project stages contributes to de-risking a project.

Furthermore, the regulatory rules of engagement are changing. Carbon pricing will have profound impacts on projects' financial viability. Likewise impactful, the coming EU Taxonomy [6] and similar rulesets are introducing new market conditions. Access to finance (e.g. EU funds, or Climate Bonds [7]) will depend on environmental, social, and governance (ESG) performance. ESG performance and impact will be core criteria for successful market competition. This affects not only finance but fundamentally all aspects of

project development. Project layout, implementation, and operations will change, as will government permits and licences.

We engineers are usually quite distant from policies and market rule design. However, we will be fundamentally affected, no matter in which role, or which project is involved. It is however essential to understand this new market environment.

4 CONCLUSIONS AND RECOMMENDATIONS FOR THE UNIVERSITIES OF TODAY AND TOMORROW

It is imperative to prepare the engineers and decision-makers of tomorrow, how and why sustainability is a core feature of project layout, operations, permits. Equally, as the „hard factor aspects" of structural safety and financial viability are at the core of planning and implementation of projects, sustainability is an inseparable part of good project development. This needs to be reflected in university education.

Based on my professional experience in planning and consulting large water infrastructure projects, and teaching at Konstanz University of Applied Sciences, my recommendations are:

1) Full embedding of sustainability topics (ESG) in the core courses and subjects.

This should be done in full analogy to topics like infrastructure safety, cost, and performance efficiency (and rather than offering stand-alone 'sustainability' courses. We don't do 'cost' courses either).

2) Demonstration of practical cases.

These should be cases of successful projects, as well as cases of complications, misjudgements, failures. Those cases are least well-published, but often very valuable for learning. Invitation of external experts and practitioners, also from the wider policy space e.g., UN Organisations, development banks like KfW and DEG, governmental regulatory bodies and federal agencies, and non-governmental national and international organisations.

3) Exposure to actual projects and practitioners.

Field trips and site visits, and the sharing of practitioners' experiences are extremely powerful for learning and for deeply understanding a profession. Almost without exceptions, project engineers enthusiastically welcome student groups and the opportunity to share their experience and knowledge. Our engineering students greatly benefit from our faculty's annual water-energy-environment one-week field trip.

In conclusion, rather than perceiving sustainability as a costly burden on a project, I strongly advocate teachers and students to proactively accept the sustainability challenge. Engineers of the future need to get ready and well-prepared for it. We all need to embrace the understanding that only sustainable projects can be good projects.

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»UNFOLDING SPACES« – INTRODUCTION OF A METHODICAL-DIDACTICAL TEACHING CONCEPT FOR A VIRTUAL AND INTERCULTURAL COOPERATION COURSE IN ART-BASED RESEARCH AND DESIGN STUDY PROGRAMMES

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Abstract. *In this paper, we present a methodical-didactical teaching concept that was conceived during the first lockdown of the Covid-19 pandemic and implemented in the winter semester 2020/21 as a joint course between the Department of Design at the Potsdam University of Applied Sciences (FHP) and the School of Design at the National Taipei University of Technology (NTUT). The teaching concept was developed as a reaction to the limited mobility between the two universities and the resulting question of how students—despite lockdown—can be enabled to gain international experience and intercultural exchange during their studies.*

The aim of the concept is a virtual course for design disciplines that promotes exchange and forces participatory social design solutions. Central challenges for the design of public spaces in Europe and Southeast Asia are addressed. In an intercultural comparison, design solutions and interventions should be developed for conflicting goals such as competition for space, ecological issues such as heat stress and noise, protection of privacy versus security, and for linking virtual and physical spaces. Meanwhile, the course is being further expanded and improved so that it is continuously offered, embedded in the curriculum, and as attractively transferable as possible for diverse collaborations in artistic research and design study programmes.

The project »Unfolding Spaces«, which arose out of necessity, contributes directly to the internationalization and digitalization—and in the medium term also to the flexibilization of the study programmes—of the FHP and the NTUT. With the planned international cooperation format, we expect long-term continuous cooperation of numerous digital paths—even beyond pandemic times.

In this paper, we discuss the course topic in a cross-national context, show creative qualification goals, and outline the thematic course progression; in addition, we use the example of a session of the course to show how different activation, discourse, and work formats both promote exchange between participants and can be relatively well countered by the limitations of online teaching.

Keywords: art-based research and design, collaborative and intercultural, joint-course concept, student pandemic mobility

1 CHANGING DESIGN EDUCATION

The continuous expansion of the application fields of design, e.g., “Social Design” in the context of social innovations, “Business & Service Design” for economic and organisational issues as well as the ever-

increasing demand for co-design and design thinking offerings all require an adaptation of the academic design curricula.[1]

In 2019, Ken Friedman proposed a list of challenges for design,[2] postulating that "these challenges create a new context for the design process. Some forms of design remain similar to what they have long been. Other forms of design emerge in response to new developments, new tools, new situations, and new technologies." According to Friedman, a distinction can be made between four overarching types of challenges [1]: "**Performance Challenges**: Challenges related to what designers must do, rather than a challenge to their skill sets. **Systemic challenges**: Challenges related to addressing the entire system, not just a single part. **Contextual challenges**: Challenges related to dealing with complex systems that are strongly affected by their environment, local culture, and political concerns. **Global challenges**: Challenges related to dealing with complex sociotechnical systems."

In our paper, we will take a closer look at the "contextual challenges" and "global challenges" for aspiring designers. We focus on the analysis and design of public spaces (as a typical challenge in social design) and combine this with culturally sensitive questions in a comparison between Europe and East Asia.

The framework for this teaching project is a long-standing DAAD-ISAP partnership (International Study and Training Partnerships) between the Design departments of the University of Applied Sciences Potsdam (FHP) and National Taipei University of Technology: Taipei Tech (NTUT), Taiwan. Both universities are united by their interest in transdisciplinary issues in urban space and their efforts to jointly develop and test innovative teaching and learning concepts at the interfaces between service design, social design, urban design, and related perspectives. The COVID-19 pandemic and the associated halt to all physical exchange formats has resulted in us developing an ad-hoc remote course offering for design students at both universities and offering it in the winter semester 2020/21. The course is aimed at students of all design courses at FHP and NTUT and from its transdisciplinary perspective, combines urban geography, urban sociology, and urban planning approaches with design potential for sustainable infrastructures, urban logistics, urban technology, and urban furniture, beyond the mainstream trends of future mobility and smart city concepts. In the following section, we justify the selection of our course topic—Social Design for Public Spaces—as well as the methodological didactic concept and the integration into our curricula.

2 PUBLIC SPACES IN TRANSITION

"Attractive cities and municipalities are vibrant, safe, sustainable, and healthy. They are characterized by a wide range of well-designed, open public spaces which facilitate encounters and encourage communication. As a starting point for urban development planning, open spaces provide basic qualities such as interconnecting paths. They form the fundamental and enduring structure of a city and show its character and rhythm." This is how the Baukultur Report 2020/21[3] summarises the outstanding importance of public spaces for liveable cities. The recommendations for action include demands to use public spaces as a driver for urban development, to develop them for health and recreation, and to increasingly create new mixed spaces, i.e., considering functions and uses together rather than in parallel. New mixed spaces, therefore, activate places and concentrate diverse offerings in one area. In this way, they make an urban development contribution to the inner city and consider different user interests. Finally, public spaces have a deciding impact on the levels of action relating to climate protection and climate impact adaptation (cf. Fig. 1).

Public spaces range in form from informal street corners to spacious urban facilities. On a larger scale, formal public spaces have long had an important role as centres of settlements of all kinds and as focal points of public life, activities, and events. On a smaller scale, they can simply be a place to rest, linger, play and meet, while providing a visual break from the flow of streets in urban areas.[4] They include everything from traditional squares to casual urban spaces to a range of new types of spaces [5] that challenge our perceptions—physical, social, and in terms of their governance—about what public spaces should be.

Designers are increasingly involved in research and practice with questions concerning the design of public spaces. Whether it is in the form of moderating co-design formats of participatory urban planning or as a street furniture designer on behalf of the public sector or as a founder and service designer for new –usually app-based – service offerings for delivery services, mobility, or health in the city. This challenge deals with a complex system in a situated context. Skills in the holistic perception and evaluation of physical spaces, knowledge of social science and technological tools for mapping spaces as well as experience with participatory design formats and moderation processes in diverse multidisciplinary teams are key success factors for future professional practice.

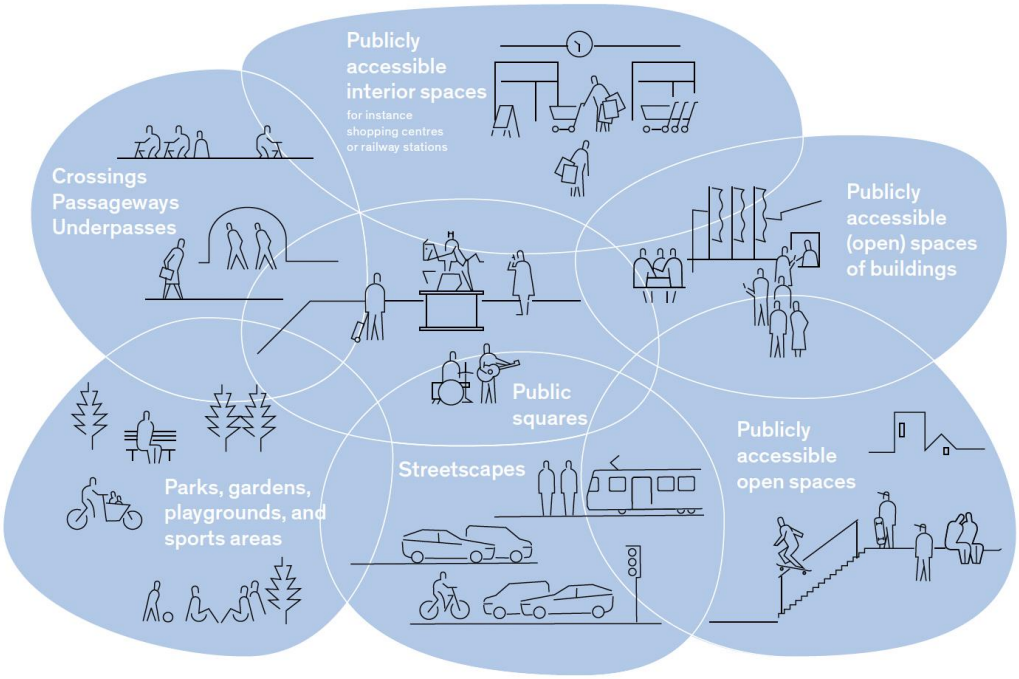

Figure 1: Public Spaces (Federal Foundation of Baukultur 2020, 6)

3 SOCIAL DESIGN FOR PUBLIC SPACES

The course addresses central challenges faced when designing public spaces in Europe and Southeast Asia. In an intercultural comparison, design solutions and interventions will be developed for conflicting goals, such as competition for space, new concepts for spaces for the general public, ecological issues such as heat stress and noise, freedom, and security, as well as for linking virtual and physical spaces. To this end, student teams in Potsdam and Taipei will jointly explore public spaces in their respective urban contexts, share experiences, derive problem areas and challenges, and develop prototype solutions in the interplay between global developments and local impact.

The **first objective** of the course is the individual physical exploration of urban space as the combination of multisensory perception of public spaces by mapping different spatio-temporal thematic levels of the city (cf. Tab. 1). The theory behind this is that individual resensitisation to the perception of diverse physical infrastructures, interpersonal interactions, and other ecological living environments of the city are prerequisites for the professional co-design process later in urban planning. Otherwise, there is a risk of developing superficial solutions without considering the multitude of complex interactions between the different stakeholders and infrastructures. Observing the increasing fixation on mobile devices when (not) experiencing public spaces and the almost complete reliance on navigation systems is a worldwide phenomenon and thus a common starting point for the students in Germany and Taiwan.[6] As a result, many design tasks in direct neighbourhoods are usually overlooked or not even noticed.

The **second objective** of the course is to raise awareness of cultural diversity in the design process. The basis for this is the mutual presentation of individual mapping of specific urban levels in Taipei and Berlin/Potsdam in mixed teams from Taiwan and Germany. Commonalities in how public spaces are perceived and identical or different socio-cultural problem areas in the exploration of space are identified and discussed. In this way, an empathetic understanding of cultural diversity is gained that has a high degree of authenticity due to the direct link to the concrete experience and mapping by the course participants.

The **third objective** of the course is the design and prototypical implementation of a team project to restructure and further develop public spaces in intercultural teams in Taipei and Berlin/Potsdam. Team building under remote conditions as well as the best possible combination of the students' respective cultural, artistic/creative, and technological skills were the main challenges of this part of the course. By building prototypes, carrying out iterative tests with the target group, and receiving feedback from the other country, the students gradually advance towards good design decisions. In detail, the course consists of 15 learning units (10 ECTS).

Table 1: Summary of learning units

A) **Analysis. Sensual fieldwork & thematic cartography**	**B) Synthesis. Design process**
LU 1: A look at the city: remote sensing and pattern recognition	LU 8: Collection of first ideas
LU 2: A look at the surroundings: topology and landmarks	LU 9: Defining human needs
LU 3: A look at infrastructures	LU 10: Write your design brief
LU 4: The moving city: direction, density, and time	LU 11: Ideation & prototyping
LU 5: The invisible city: sounds, smells, and feelings	LU 12 Storytelling with use cases
LU 6: The social city: politics and culture	LU 13: Testing and iteration
LU 7: Documentation & reflection	LU 14: Presentation

4 EXAMPLE OF A LEARNING UNIT

Each learning unit is split into three blocks, where the first block introduces the respective topic, the second serves to start thematic processing, and the third leads into the associated fieldwork. Intercultural input shortens the second break time but explicitly serves communal mental relaxation/excitement and collection. In each case, the synchronous course time ends with the offer of a thematically appropriate student tutorial, which is usually offered by the research assistant.

Table 2: Example of a learning unit

Welcome & intro	15 min	Welcome and introduction (status and agenda of the unit)
Call to action	30 min	Call to action (warm up exercise matching the topic of the unit)
Input lecture	45 min	Lecture by a professor on the subject matter of the LU
Break	30 min	
Preparation of the discussion/workshops	15 min	Preparation of the discussion (collecting questions & hypotheses)
Work in small groups	30 min	Discussion in small groups (in breakout rooms)
Summary of the discussion and results in the plenary	45 min	Discussion in plenary: summary of the group discussion and clarification of open questions
Break	15 min	
Intercultural input	15 min	e.g. Online Qigong, guided by Prof. Ryan Wang
Homework	15 min	Homework given and discussed: field research and mapping exercise
Tutorial support	60 min	Student tutorial—e.g., on the use of tools; on the joint creation of data sets, visualisation templates, etc.

5 EXAMPLE OF A STUDENT PROJECT

The course in the winter semester 2020/21 was taken by 24 design students at the universities in Potsdam and Taipei. The split between the two countries was equal. Mixed teams worked on 8 freely chosen projects on the design of public spaces in Berlin/Potsdam as well as 7 projects in Taipei. The variety of topics impressively reflects the interest of students in both countries in ecological and social issues, as well as topics of knowledge transfer and storytelling on the history of older city neighbourhoods in particular.

The "Even 5 Minutes - Redesign of a Tram Station in Berlin" project (designed by Hsuan Lee) will be presented as an example. "Even 5 Minutes" is a project that focuses on redesigning tram stations in Berlin to provide a better "waiting experience" for people waiting at the stations. This project is particularly interesting because it was initiated by a Taiwanese exchange student in Berlin. The starting point was her observation that in Berlin—in contrast to Taipei—people smoke at tram stations, and the stations are littered with rubbish and broken bottles. The project aims to redesign the tram station to allow smoking, but also to offer non-smokers better air quality while waiting. The solution provides for an air purification system that is available for each smoker as a covering (cf. Fig. 2). The covering also displays relevant information, such as the current time, when the next tram will arrive, the current temperature, etc. The system is complemented by versatile seating furniture. The project exemplifies confrontation with an unfamiliar foreign spatial experience (smoking at tram stations), and a technological solution approach, which in turn is based on the experience of massive technology deployment in public transport in Taiwan. The solution was the starting point for a discussion in the course about cultural differences concerning how public spaces are used in Germany and Taiwan and the appropriateness of technical solutions and the risk of vandalism.

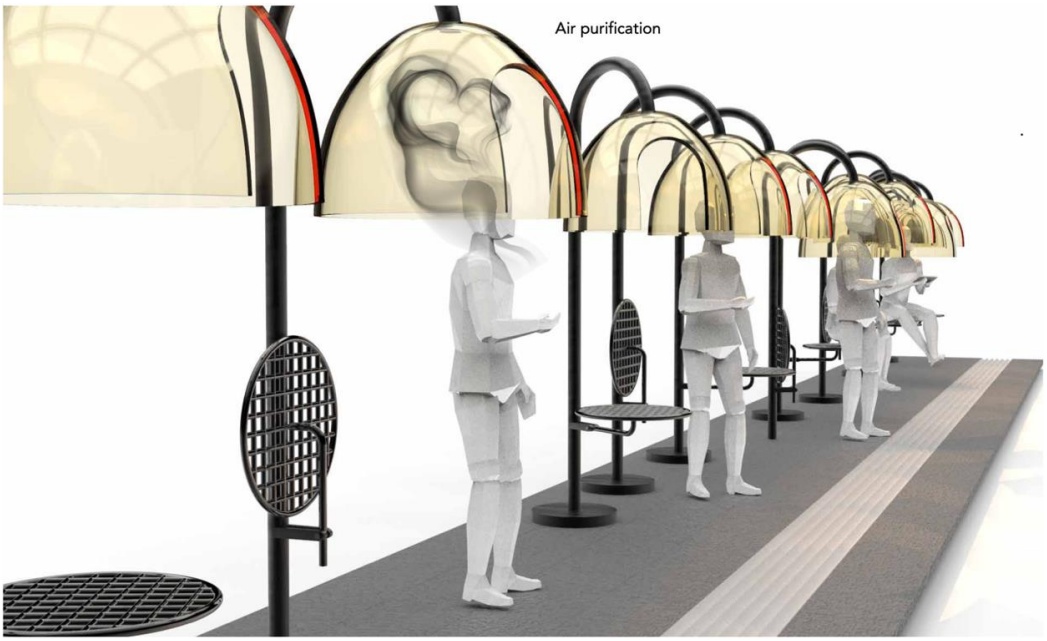

Figure 2: "The Bulb"– An air purification system at tram stations. (Rendering by Hsuan Lee, University of Applied Sciences Potsdam 2021)

6 FINDINGS AND OUTLOOK

The reflection indicates that the individual exploration of one's own urban space using set schemata as well as the presentation and discussion of mapping in the group led to a strong sensitisation for the problem areas and the potential for one's own neighbourhood. Through this format, the "foreign" city could only be explored visually and cartographically in an exemplary but authentic way. Intercultural differences in the

perception and evaluation of pollution and litter in public spaces, for example, as well as a certain lack of consideration for others in Berlin and Potsdam, were discussed among the students in the course.

Applying design methods and going through the design process revealed the globalisation of an iterative design process, which is now taught identically in many design colleges worldwide. The advantages of this development—a common understanding of methods and processes in intercultural teams—are offset by the disadvantages of an overly schematic standardised understanding of design and solutions that no longer takes sufficient account of attention to and appreciation of local requirements and approaches to solutions. To counteract this, local survey methods should be used more frequently to be able to discuss differences and similarities in a more conscious way.

There are plans to further develop the course form thematically and didactically. To this end, a DAAD project in the International Virtual Academic Collaboration (IVAC) programme was applied for and approved. The goal is to travel to Taiwan with a group of 12 students in spring 2022 and to further develop the course format together with students from NTUT. For example, additional technological tools (e.g. 360-degree cameras) are to be tested together for the perception and mapping exercises in the urban space. The excursion and its findings are to be extended to similar courses with other exchange partner universities in South Korea and Japan in the context of "Social Design" in the following semesters. Even with the experience gained so far, flexible blended mobility is available as a mixture of real mobility and virtual mobility.

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METHODOLOGY FOR ANALYSING PERSPECTIVES AND CONCLUDING POTENTIALS FOR FIELDS OF STUDIES

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Abstract. *Progressive education at universities of applied sciences is constantly adapting to changes in its professional and academic field. Due to the ever-accelerating economy, departments are facing increasing pressure to redesign their curricula in ever shorter periods. Thus, it is crucial for departments to identify potentials for resilient education in an effective and reliable manner. This paper introduces a methodology that aims to analyse the perspectives in theory and practice of a discipline in order to deduce grounded potentials for future-oriented education. The methodology has already been applied in the highly dynamic field of design studies for the department of design at the HTWG Konstanz but will be described below as a generalized methodology that can be usefully adapted to any discipline. (An overview of the findings of the analysis is given in the paper 'Potentials for Resilient Design Education at Universities Of Applied Sciences', published simultaneously via HTWG Konstanz.)*
The first section briefly introduces the starting point of the research. The second section describes the background of the research design, which is based on social science methodsand explains the qualitative and explorative design underlying the method. The third section explains the semi-structured expert interviews and the interview guides that were used to provide meaningful data. The related sampling is discussed in the fourth section. The fifth section explains the method of deductive-inductive data analysis using qualitative content analysis. The sixth section describes the method of inductive theory building using grounded theory methodology. Following this approach, potentials for resilient yet future-oriented education can be defined and their implications and consequences for students, teachers, and education systems can be outlined. Finally, the seventh section summarizes the results with a brief outlook.

Keywords: Higher education, future-oriented, resilient, curricular development, universities of tomorrow

1 INTRODUCTION

At a time when socio-economic change is accelerating and technological transformation is shifting the foundations of communication and agency, higher education institutions face a profound challenge: they need to respond to these developments at ever shorter notice in order to adequately educate and train the experts, specialists, and leaders of tomorrow. This leads to one key question: What does university education have to be capable of in order 1. to prepare properly for the reality of work and 2. to be able to adapt to future challenges? Or—to put it another, more active way: How do we identify the potentials for future-oriented and resilient university education?

It is difficult to answer this question for higher education as a whole. Rather, the requirements of the professional world must be defined for each course of study and the potentials derived from them. The present research understands potentials as the possibilities for a meaningful redesign and reorientation of teaching and its content given the difficulties mentioned above. Accordingly, the goal is to formulate principles and means according to which contemporary and future-oriented teaching can be aligned to be able to continuously react to changes. These can be content-related potentials such as teaching paradigms and principles, but also structural potentials that relate to the implementation of such content in the teaching context. For this purpose, relevant data have to be collected and valid methods have to be applied in order to interpret the data in a meaningful way. The research design explained in the following is a practicable basic

framework, with the help of which, meaningful data can be collected, evaluated, and interpreted, and that can be adapted to different disciplinary contexts.

2 RESEARCH DESIGN

In order to analyse the realities of a discipline, it is not sufficient to deduce hypotheses from theoretical models in the close environment of the universities. The thereby missing objectivity [1] can be approached with the methods of empirical social science. These methods follow three guiding principles: the appropriateness of method and theory to the subject matter, the consideration, and analysis of different perspectives, and the researcher's reflection on the research as part of the findings.[2] The appropriate method is chosen in response to the object, to examine the object in its complexity and wholeness in its everyday context. The appropriateness of the method to the object is expressed in the principle of openness. Thus, it is less about verifying what is known (such as theories already formulated in advance) than discovering something new and developing empirically founded theories.[3] With particular regard to the principle of openness, we have decided to adopt a qualitative social research method for the analysis of the subject matter, which is based on the difference of subjective perspectives and intends to learn from unforeseen irritations. Therefore, we chose to proceed exploratively to identify contextual and causal factors.

2.1 EXPLORATIVE DESIGN

Disciplines—as our object of study—are subject to socio-economic change and the technological transformation of the professional world. It can therefore be assumed that the current state of research on the subject (no matter in which discipline) is too incomplete to formulate specific questions, descriptive dimensions, or hypotheses. This problem can be approached with the key element of explorative studies: getting as close as possible to the object of research to arrive at new, differentiated questions and hypotheses. Explorative studies try to achieve this proximity with methods such as participant observation or open interview forms.[4]

2.2 CONTEXTUAL AND CAUSAL ANALYSIS

Within the data collected, qualitative research then attempts to empirically identify causal mechanisms and subsequently generalise them. For this, the contextual analysis identifies individual variables from the subject and connects them. These connections are examined for cause-effect relationships. Thus, generalised models are created, from which predictions and implementations can be derived.[5]

3 EXPERT INTERVIEWS

Empirical social research focuses on the observation of social reality. In addition to observation in the narrower, passive sense, possible procedures also include active questioning of people involved in the objective processes. Questioning methods attempt to translate the research question into questions for interlocutors.[6] For the explorative research of perspectives in the field of study, we decided to talk to experts from the field. This made it possible to gain reliable insights into the subjective experience of the interviewees from the various disciplines and to explore concrete options for action in greater depth.

3.1 SEMI-STRUCTURED INTERVIEWS

In the spirit of qualitative research, we conducted semi-structured interviews with the experts. In these guided interviews, we worked with a catalogue of questions (the guideline) in which neither the formulation nor the order was binding. In addition, questions could be deepened in the course of the interview. Such interviews can be deepened and expanded by further questions that arise in the course of the interview. In this way, the interview explored what knowledge the interviewee had without losing sight of the goal, namely to analyse perspectives and potentials in fields of study. At the same time, this approach makes it

possible to deal with the initially loosely connected aspects of the extensive topic in a limited amount of time.[7]

3.2 INTERVIEW GUIDE

In this sense, the guiding questions should provide an open framework for the conversation. They should therefore have little influence on the direction of the conversation but ensure that all important aspects of the topic encounter are covered. What is asked depends on the theoretical preliminary considerations and the reactions of the interlocutor in the interview. The questions should therefore be open, neutral, simple, and clearly formulated.[8] In no case should they prescribe a particular answer. One should not fall into the trap of pursuing one's interests too strongly to prevent one's own bias.

As the different disciplines of studies may differ greatly, the interview guide must be designed separately for each discipline and cannot simply be adapted by others. However, this does not only concern the different disciplines. If experts differ in their involvement in the process to be reconstructed and thus each expert has a specific knowledge, then it makes sense to develop a separate interview guide for each type of expert.[9] In this sense, the different questions and question categories result not only from the disciplinary context but also from the professions of the interviewees. In our case, for example, the following question categories emerged in the field of design theory: 1. introduction, 2. concept of discipline, 3. relationship between theory and practice, 4. means and methods, 5. relevant competencies, 6. the state of the art of teaching, 7. ethics and morals.

4 SAMPLING

To define an initial critical mass of interviewees, the basic sampling should be based on a holistic view of the field. In addition to contacts from practice, experts from academia can also play an important role in the sampling. Who has the information necessary for gaining knowledge can differ greatly in the different disciplines. Therefore, as with the development of the interview guide, a subject-specific approach is necessary. The sampling areas in our case were divided into practice, research, and specific deepening. To find relevant contact persons for our research question, we referred to the following general parameters for quality assurance.

In the case of practitioners, the following factors should be present: the person has training and activity in the field, an overview of the field, and has a direct relationship with young professionals. In the case of researchers, the following factors should be present: the person has training in the field in question, activity in the relevant scientific discourse, and a direct relationship with students. To avoid the trap of sampling bias, the sampling should be non-closed and thus semi-adaptive. Due to the open nature of the guiding question interviews, particularly relevant topic areas can still be identified during data collection. These could be deepened in conversation with experts at the intersections to these areas with adapted guidelines.

To be as targeted as possible in the selection process and to cover a holistic view of the discipline, different roles per research group should be defined in advance. In our case, these roles resulted from sub-areas of design research as well as from different areas of design practice. Once the interview guide has been prepared and the roles in the sampling have been filled by suitable persons, the persons can be interviewed and the data collected.

5 DATA ANALYSIS

Once the data have been collected, it is necessary to choose a suitable method of analysis in order to deal systematically and profitably with the raw material. A common methodology in the social sciences for evaluating exploratively generated data is called a *Qualitative Content Analysis* (QCA), which makes it possible to relate different sections of data utilizing abstract codes to find observations and correlations.[10]

Since the goal of the present research is to extract claims from many different statements, such a procedure is appropriate.

5.1 QUALITATIVE CONTENT ANALYSIS

The classical QCA sees itself as a qualitatively oriented, category-guided text analysis and has a strong focus on the raw material. The goal here is primarily to reduce and then summarize the material by breaking down the temporal structure of it through a pre-fixed deductive system of categories, where *deductive* means that the category system is derived from the prior considerations and remains unchanged during the process. For this purpose, relevant research aspects are explicated as precisely defined categories of a category system, and relevant parts of the material are deductively assigned to these categories by pre-fixed rules for matching the data to the right categories. It is important to repeatedly check these categories on the material during the process and modify them if necessary.[11] With regard to validity, however, it seems of particular importance to allow for unexpected theory building from the data despite the systematic and rule-guided approach. Thus, it is sometimes necessary to form categories inductively from the material to remain open to unforeseen information throughout the analysis process. *Inductive* in this sense means that the category system is developed from the material during the systematic reduction process. In this way, content analysis allows us to capture not only the formal textual components but also deeper structures of meaning. Therefore, we applied an inductive-deductive category system.[12] The exact procedure is explained in the following.[13]

5.1.1 Steps of the analysis

The data was classified by a coding procedure, whereby certain data sets are categorized by predefined code terms in order to be classified in the category system. Thus, before the first material run, firstly, units of analysis have to be defined, such as the coding unit (e.g., a word), the context unit (e.g., a response), and the evaluation unit (e.g., an interview).[14] Second, the categories of the interview guide (such as Concept of discipline, Relationship between theory and practice, etc.) were transformed into a predefined category system with upper and lower categories in order to set the basic structuring dimension of the analysis. And third, coding rules were established for the comprehensible and selective definition of when a material component falls under a category.[15]

First material run: paraphrasing and deductive coding

In the first pass of the material, the textual components of the interviews were summarized into a predefined textual form limited only to the relevant content (paraphrasing). These paraphrases were then coded deductively, which means that they are categorized with the predefined codes in order to be classified in the category system.[16] After the first working through the texts, the results were compared and category definitions were adapted to the characteristics of the assigned material components.

Second material run: paraphrasing and inductive coding

Then the material was gone through again in a second material run, after which the results were compared, existing categories were revised and the selected paraphrases were brought to new categories inductively formed from the material [17]. After this, the results were compared, existing categories were revised and the selected statements were brought to new categories. By this, we extended our deductive category system to an inductive-deductive category system.

Third material run: paraphrasing and deductive-inductive coding

In a third working-through, existing codings were checked for consistency concerning the new category definitions and coded deductively-inductively on the new category system.[18]

6 INDUCTIVE POTENTIAL GENERATION

By this procedure, one can provide a thematic framework in which the different phenomena and structures of the respective discipline can be identified and classified. However, the results in this form cannot be transferred into a uniform interpretation. Thus, to be able to develop potentials for sustainable teaching from this, not only an analysis is needed, but also a theory-building approach that elaborates data-founded causal relationships. A common approach of this kind can be found in the *Grounded Theory Methodology* (GTM), which systematically evaluates qualitative data with the aim of inductive theory building.

6.1 GROUNDED THEORY METHODOLOGY

GTM, developed by the sociologists Anselm Strauss and Barney Glaser, is a methodology with the aim of using coding procedures to extract various principles, causal relationships, and motivations from qualitative data that cannot be derived from logical presuppositions.[19] The focus is on the process of developing and elaborating empirical theories, which takes place in parallel with a repetitive process of data collection, coding, and analysis, repeatedly referring to the raw data material to ensure validity[20]. As in QCA, this is done through the process of coding, but in different coding phases with differentiated features.[21] Central is the formation of an inductive category system with different categories on which theoretical claims can be grounded. However, the definitions of these categories here do not come from the data or the interview guides, but from various external models, which, depending on the intended kind of theory to be elaborated from the data, provide various guides for theorizing and categorizing the codings. In the process described here, it was the so-called *coding paradigm*, with whose predefined categories it was possible to classify and relate central phenomena within a discipline (in our case: potentials for future-oriented and resilient university education), their causes and conditions, related strategies for action and ways of dealing with them, as well as consequences, contexts, and circumstances of such phenomena.[22] In our case, this made it possible not only to inductively identify potentials for future-oriented and resilient design education from the collected data but also to gain a more comprehensive view of our own discipline. In the following, it is briefly described how potentials can be formed inductively from the results of the qualitative content analysis using the grounded theory methodology.

6.1.1 Process of potential identification and dimensioning

First, based on the QCA categories, we looked for central phenomena that could be characterized as potentials by the mentioned characteristics. To be able to name several potentials, the results of the data evaluation were looked at several times under different focal points. Second, based on the predefined categories, various challenges, deficiencies, opportunities, and risks could be related to the potentials found, thus revealing the general conditions under which a specific potential becomes necessary. Third, means and forms to deal with the mentioned challenges and with which a potential can be implemented in teaching were categorized. Fourth, probable impacts on students, teachers, and teaching systems were categorized and related to the potentials. Finally, the result was brought together in a description of different orientations and courses of action for teaching (in our case for design education).

7 CONCLUSION

In this paper, we have shown how a qualitative analysis can be used to identify perspectives in the theory and practice of the discipline and to potentials for a future-oriented education can be identified without spending massive resources. In infield research, selected experts of the discipline's theory and practice can be interviewed. Central parts of the answers can be summarized and related in a system of categories. Based on this analysis and through inductive theory building, general potentials of education can be defined.

This approach is well suited to the subject of matter—identifying potentials for future-oriented education—from different perspectives. First of all, the potentials are relevant. They do not emerge from the interests of a closed group of stakeholders. Rather, they emerge from data-based correlations, and thus from the

unbiased consent of a diverse many. Thus, we can argue the results to be as close as possible to all social realities of a discipline. Furthermore, we set up the process as straightforward as possible. It requires few resources and people and can be coordinated from a central point. This allows one to keep pace with the accelerating change and achieve qualitative results quickly. With the same experts, the process can be on-going developed and expanded.

In short: The approach is desirable and feasible. However, there has to be a commitment at the highest level of the university to face the challenge in a structured and coordinated way. For instance, an Office for Curricular Development could coordinate and moderate the ongoing evaluations in the degree programmes. Then, the analysis and the interpretation could be done by the office, in close collaboration with the study programmes. Internal quality assurance funds could cover the expenses for the study programs. Due to this central coordination and moderation, falsifiability and comparability could be guaranteed. By building up this expertise in-house, the evaluation would not only be as scalable as possible but it would also provide a foundation for an ongoing and effective interdisciplinary exchange.

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(12) Schreier 2014

(13) Qualitative content analysis was originally developed as a rule-based basic method by Philipp Mayring from quantitative research (cf. Mayring 2010b: 601). For the reasons mentioned above, it was then expanded by Jochen Gläser and Grit Laudel into another variant (cf. Gläser/Laudel 2010: 198f.). However, current approaches no longer speak of different variants here, but of a toolbox concept in which different options are added depending on the research situation and question (cf. Schreier 2014 and Steinhardt 2019). Accordingly, QCA does not represent a fixed method, but is characterized by many determinations and decisions. To find a suitable flow model, one has to select and apply the appropriate basic form or combination from proposed models (see for a good overview Schreier 2014). The methodology described in this paper follows Mayring's basic deductive procedure, but opens up for inductive category formation on the material following Gläser and Laudel.

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(15) Furthermore, in qualitative research it is generally important to document the procedure in detail in order to make the process with its limited standardization comprehensible for others and in the sense of good reproducibility (cf. Mayring 2002: 144f. and Steinke 2000: 324).

(16) For this step, the targeted level of abstraction was defined in advance so that paraphrases could be classified in a uniform way.

(17) Flick 1995: 412ff.

(18) This shows that this process has a great strength in that it can be repeated in any number of passes and adapted again and again. On the one hand, this allows one to continue to be selective and precise, and on the other hand, one remains open to new relationships and content.

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POTENTIALS FOR RESILIENT DESIGN EDUCATION AT UNIVERSITIES OF APPLIED SCIENCES

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Abstract. *Design education faces a complex challenge: preparing students for professional life in an increasingly volatile market. Traditional role profiles as a maxim of a solid education are becoming increasingly irrelevant and the factors of resilience within a profession are shifting. Thus, one of the key questions for future teaching is: what are the critical skills and competencies that need to be taught to achieve resilient education in the design discipline, and how can they be taught best? This paper explains the findings of a qualitative analysis facing this question. To answer it, 21 selected experts from theory and practice in the German design landscape were interviewed. The results were analyzed using social science methods. Consistent potentials for a resilient design education were then derived from the current perspectives of the discipline gathered from the collected data (whereby potentials are understood as the possibilities for a meaningful redesign and reorientation of teaching and its topics regarding the difficulties mentioned above).*
In the following, the first section briefly discusses the research design used to analyze the data and also to develop the theory of the potentials. (This paper is based on the paper "Methodology for the Analysis of Perspectives and Conclusion Potentials for Fields of Study", published simultaneously via HTWG Konstanz, in which a detailed description of the used methodology is given.) The second section then explains the findings in its five main potentials: responding to present changes; encountering cross-disciplinary approaches; collaborating with humanities and social sciences; provoking reflection; combining theory and practice. Finally, the results are discussed in the third section.

Keywords: Design education, future-oriented, resilient, curricular development, universities of tomorrow

1 RESEARCH DESIGN

With particular regard to the principle of openness, we have decided to adopt a qualitative method of social research, based on the difference of subjective perspectives and intending to learn from unforeseen irritations. Because the current state of research was too incomplete to formulate specific questions, descriptive dimensions, or hypotheses, we have applied an *explorative design*, in order to get as close as possible to the object of research without bias. For the exploration of perspectives in design, we chose to interview various experts in design. Semi-structured interviews with guiding questions provided an open framework and exerted as little influence as possible on the course of the conversation.

For the *sampling* in the field of design, we contacted a. *practitioners*, who were trained and active in the design, had a broad overview of the field and direct relation to young professionals. The eight practitioners to be interviewed were selected by following predefined roles: communications, brand design, full service, innovation, freelance, digital, service design, and spatial design. Furthermore, we contacted b. *researchers*, who were trained in design, active in the scientific discourse, and had a direct relation to students. The eight researchers to be interviewed were selected by following predefined roles: product design, interactive media, social design, design methodology, visual rhetoric, aesthetics, art theory, and artistic research. During the research fertile areas of intersection were revealed. Following the concept of openness, we applied a *theoretical sampling* and included the fields of sociology, psychology, philosophy, design education, and higher education development with one interview each. All interviews took between 30 and 60 minutes each and were conducted in person by one researcher and two assistants.

To analyse the collected data, we applied a *qualitative content analysis*, which broke down the temporal structure of the data. To connect the data in a category system, we took an inductive-deductive approach in two stages. After doing so, 71 single categories emerged, which can be subsumed into five main categories: 1. Understanding design, 2. The state of affairs in design, 3. approach to design, 4. intersections to design, and 5. design education. In a final step, we interpreted the analysis, applying a grounded theory methodology: central phenomena were identified, their general conditions were found, means and forms were categorized, probable impacts were related and courses of action for design education were enclosed.

As a result, we were able to identify and describe five key potentials for resilient design education at universities of applied sciences. By proceeding in the above-described way, we were able to ensure that the potentials did not emerge from the interests of a closed group of stakeholders. Rather, they emerge from data-based correlations, and thus from the unbiased consent of a large number of experts in design.

2 FINDINGS

2.1 RESPONDING TO PRESENT CHANGES

2.1.1 Imparting current contextual knowledge

Design is dialectically related to the socio-economic situation. To respond appropriately to current changes in the world, design education must impart the current contextual knowledge. In order to create formats that continuously address current social, ecological, and economic issues, structures for identifying topics and analysing world events must be installed in education. For example, lectures and collaborations with disciplines whose focus is on the topics of current changes can contribute to the foundation of the problem-solving approaches to be developed by students. This can lead to students consciously locating themselves in the global situation and thus to a better orientation in their own field. The intrinsic motivation of students, as well as the social benefit of design, can be promoted through the in-depth exploration of relevant topics such as digitalisation and the limits of natural resources. A degree programme with a focus on such topics can contribute to the changing environment instead of being driven by it.

2.1.2 Adapting a broader concept of design

The term of design originally indicated a claim to professionalism. However, due to the democratisation of design tools, craftsmanship is increasingly losing its value, and due to the increased complexity of the globalised world, the relevance of design is shifting to pre-production, i.e., to conception and interaction with people. In order to establish a process-oriented understanding of activity in education, a broader concept of design must be adapted. By questioning established assumptions of design, new ways of thinking and self-understanding can emerge. Design education can become an integrative process of collaboration in which designers could use increased scopes of action and interact confidently with other disciplines through increased connectivity. Ultimately, the deeper awareness of problems would lead to better product quality and thus higher relevance of design.

2.1.3 Unlocking progressive fields of practice

The democratisation of design tools is also shifting the definitions of professional design. Thus, it seems more important for the design to unlock progressive fields of practice. In order to find partner organisations for such activities, networking with alumni in the industry can be of assistance. Design thinking can be taken up as an example of successful integration of design processes in enterprises and a broader concept of design can contribute to the understanding of the added values of design in enterprises. Finally, designers can increasingly take on conceptual and strategic advisory roles in companies. The boundaries of the discipline may shift, leading to a progressively broader understanding of design activity in general. The integration of theory-based fields of work may be established over time, may become an integral part of the job description, and may contribute to job security in design-related professions in the future.

2.1.4 Exploring new ways of working

Digitalisation has changed essential practices in the design industry and continues to drive further transformation processes. Looking into the future of design education, new forms of practice need to be explored in order to discover new practices and to adopt adapt innovative technologies to existing practices. In this, universities of applied sciences can be considered a safe space for the experimental exploration of new possibilities. Technological developments, such as artificial intelligence, can have thematic relevance and be implemented in education with an expanded focus on user interface design and user experience design. The strategic moments of design require the discussion of the means and methods of the problem-solving process. Agile work processes and changed practices, such as workshops or design sprints, can help to continuously enhance the issues of these processes and to address problems in a contemporary way. The steady integration of new technologies promotes an understanding of design that is emancipated from its media and provides the opportunity to come across unexpected solutions that are beyond the traditional categories of design. The added value of design can thus spread into new fields, which in turn could contribute to a broader understanding of the discipline.

2.2 ENCOUNTERING CROSS-DISCIPLINARY APPROACHES

2.2.1 Empowering the development of disciplinary awareness

In cross-disciplinary work, it is of crucial importance to have a personal approach to one's field. Thus, one goal of design education must be that students are empowered to develop a disciplinary consciousness. For this, students must learn to know and break down the rules of their craft. Thereby, they develop creative confidence and learn to identify their strengths. In this way, they can, on the one hand, generate self-confidence to participate in the interdisciplinary dialogue and, on the other hand, achieve self-knowledge that makes them more focused and responsible towards their activity. Brought into conversation with other professional cultures, students are then able to negotiate differences and assess their efficacy through different perspectives. For this process of self-assurance, or rather self-knowledge, designers can transfer the methods of design and apply them to the discipline and themselves. Reflecting on their way of thinking in relation to other disciplines can make students realise that their unconventional approaches and their ability to act both freely and without a clear goal can establish them as a welcome dialogue partner.

2.2.2 Imparting cross-disciplinary knowledge

To make valuable contributions to society, designers need an understanding of people, their behaviours, and the world they live in. Foreign disciplines can educate about these very contexts. Design education must therefore impart interdisciplinary knowledge in order to promote the student's ability to connect with other ways of thinking and to lay the foundation for successful design development through scientific theories and methods. For this, fields in the humanities can be just as substantial as getting to know practice-oriented fields that contain design elements. In order to make functional differentiations of the disciplines visible and at the same time allow enough space for key design questions, the important aspects of the fields outside the disciplines should be extracted and made accessible to the students. For this purpose, methods from related fields can be brought to disciplinary terms and models can be formed from them. This way, students can become capable of acting beyond the boundaries of their discipline and learn to navigate in between the disciplines. Knowledge of the ways of thinking and competencies of other fields makes students capable of connecting with experts. Ideally, they achieve a new conceptual intelligence and depth through a multi-perspective understanding.

2.2.3 Establishing cross-disciplinary working

The challenges of the future are too complex to be solved alone. In order to think holistically about the contexts, it is therefore becoming more important to transfer findings from different disciplines and other scientific fields into design decisions. In order to simulate this reality of the professional world, design education must truly establish cross-disciplinary work. For this to succeed, students should be able to

synthesise the approaches and methods of the other fields with their own ones. For this, basic cross-disciplinary knowledge, in-depth subject knowledge, and, last but not least, communicative competence can be crucial. They should not only know the vocabulary of other disciplines but also be able to verbalise and address common contexts. In general, situations should be created in which new and different ways of thinking and doing are made possible. At best, this happens in the sense of the student's ' personal interests and individual project ideas. Consciously introduced and liberally applied, cross-disciplinary work can be meaningful for practice. With their approaches and their understanding of value, designers can then contribute to solving global challenges. They can be the ones who bring together people and who try to organise the process with a focus on real-world applications.

2.3 COLLABORATING WITH HUMANITIES AND SOCIAL SCIENCES

2.3.1 Collaborating with philosophy

As the design discipline operates in constantly changing and increasingly complex social constructs, the need to reflect constructs also increases. In order to be able to recognize important connections on micro and macro levels, the design discipline must be aware of the multi-layered environment in which its thoughts and results are embedded. Accordingly, design practice increasingly emphasizes thoughtful, scientifically grounded concepts and strategies, from which it follows that designers create meaningful solutions only when they can deeply engage with their problem contexts. Accordingly, in design discourse, there is not only a growing need for self-enlightenment, but also an increasing demand for reflexive content, methods, practices, and ways of thinking that sometimes come from philosophy. Philosophy - understood as a methodology of analytical and critical questioning - offers designers the potential to think critically and reflectively about the basic concepts and implications of their work. If one follows the view that thinking about practice is as important as the practice itself, then philosophy can thereby help students and teachers better situate themselves within their discipline. Moreover, as a medium of reflection, it helps students adopt new perspectives on acute problems and contexts of design practice. In terms of design teaching, this can mean that by engaging with design philosophical intersections (such as aesthetics and ethics), students become more connectable in related subject areas and their problem contexts.

2.3.2 Collaborating with sociology

All design practice is part of an overall social process and is thus contributing to social development and influencing self-understandings and ways of life. Future-oriented design must therefore put the processes of social transformation into contexts with people. Phenomena such as digitalisation and globalisation make it necessary to reflect on design practice against the background of new social and cultural conditions. Sociology understands the design as adapted to society, to the social and the cultural. Thus, sociology focuses on the social conditions of design, such as power, gender, milieu, or mass media. Knowledge about the socialisation of people can be made accessible by means of socio-theoretical texts or ethnographic experiments. By adopting an approach based on social sciences, students can learn to identify different target groups in different environments. Reflecting on people as a product of their socialisation helps students to expand their prior knowledge. The logicof consumerism reveals why people respond to something, while a basic knowledge of media sociology allows students to recognise how their work affects people. These two aspects can interact to explain how mass media function and help students in a very practical way to choose the appropriate ways of addressing their problems. Students are enabled to explore phenomena in a social context and interpret them in a design-oriented way to develop a professional sensorium.

2.3.3 Collaborating with psychology

Through ever more optimised digital ways of communication between companies and customers, design is entering more intimate aspects of people's lives. Artificial intelligence, for example, enables devices to interpret and respond to users' behaviour. The intuitive interaction with digital media and the increasing integration of technology and design in people's everyday lives leads to an increase in the responsibility of

designers. The discussion of psychological aspects and the collaboration with psychologists in design education can help to meet this responsibility. Designers can gain insights into user needs and desires concerning design from the basic subjects of psychology; more in-depth seminars on relevant models and methods of psychology would be feasible. Courses with similar topics would presumably lead designers to a deeper understanding of the human experience and can be a basis for a user-centred design. In addition, students can become more aware of people's well-being and perceptions. By understanding motivational psychology, creating positive emotional states in users can be focused on more specifically. Products based on this would be more likely to meet users' needs and potential subsequent effects of a negative experience can be better avoided.

2.4 PROVOKING REFLECTION

2.4.1 Reflecting technology

Digitalisation has changed the design process and thus the role of designers. In view of the fact that many traditional fields of design are losing their relevance, many facets of the practice are faced with the challenge of not becoming obsolete. Design education should therefore encourage contemporary approaches to technology. This way, it can empower students to use the opportunities to act in a meaningful way against the backdrop of technological, social, and civic developments. From a more differentiated perspective, design education should emancipate itself from technology. However, emancipation from technology does not mean fading it out but establishing a basic understanding of digital technologies. In the interplay of different perspectives, a space for reflection can be created that enables students to deal proactively with technological change.

2.4.2 Reflecting on possible actions and consequences

The discipline is becoming increasingly aware of the political, social, and ecological responsibility of design. In addition, the processuality of a task is becoming increasingly important in design. For a future-oriented design practice, it is therefore very important to be able to think and combine both the macro perspective, i.e., the understanding of overall contexts, and the micro perspective, i.e., the understanding of specific contexts. Prior to the initial draft, the consequences of one's work on these levels should already be considered. This means that the design process is not finished once a solution has been formulated. Students should learn during their studies to reflect on the consequences of their own decisions and to include findings in their design process. One method of establishing this in the course of studies would be to depict contexts from practice in parts of the education and to provoke critical discussions in which the whole system is analysed. Since complex problems in practice are rarely dealt with by a single discipline and consequences have to be reflected on many levels, a collaboration with diverse disciplines becomes more relevant.

2.4.3 Reflecting on the efficacy of design

Since design is also defined by the reactions it can provoke, design fields must be analysed for their efficacy. This level of reflection is an integral part of a well-founded and sophisticated design. As many factors of design often only become apparent in an interrelation with related disciplines and subjects, good design education should holistically educate designers. Students should be given scope to experience the effectiveness of their practice. Engaging with the efficacy of design can empower students to reflect on their work from different perspectives, raise their disciplinary awareness and recognise their impact on society.

2.4.4 Reflecting on ethics and morals in design

Since designers not only help shape products and digital media but also discourses and various structures of the public realm, they always bear social responsibility. Therefore, the role of design in today's society should be discussed more closely. Thus, a great and important potential for design education is to take up and deal with ethical and moral issues that arise in practice. This would ideally create an awareness of the

social responsibility of design as well as a motivation to deal with social realities and problems as a designer and to actively want to exert a positive influence. To ensure this, relevant ethical discourses, problems, and topics should be taken up and reflected regarding design practice. Ultimately, students can be prepared for the challenge of positioning themselves between an applied and commission-oriented practical world and ethical values in a sense of responsibility and maturity.

2.4.5 Reflection of the own attitude

A self-reflective and self-critical attitude is a key requirement for adapting to permanent change and for being able to shape it as a designer in a meaningful way. A critical reflection on one's attitude, therefore, proves to be an essential core competence for future-oriented designers. In this sense, design education should always be geared towards educating empowered designers who can continue their education independently, make their own decisions, and take responsibility. Students need to experience self-knowledge and self-efficacy during their studies. To ensure that students do not remain with superficial considerations, sufficient time for reflection is a driving factor. Reflecting on one's attitude can contribute to educating self-confident designers who are characterised by critical awareness.

2.5 COMBINING THEORY AND PRACTICE

2.5.1 Theory as independent practice

Theoretical reflection on the problem and the audience, on options for action and their consequences, as well as on every conceptual decision directly predetermine design. The idea of an independent design theory, which is based on these practical examples, but at the same time grants reflexive activity space for action beyond logics of exploitation, can lead to a profound understanding of theory in education. To be able to achieve this, design education should engage with phenomena in the most differentiated, theoretically reflective way possible. Thus, theory as a reflexive moment offers students the chance to engage with the design and its objects in a differentiated way, to develop more liberal thinking.

2.5.2 Theory for new perspectives in practice

In design discourse and also in design practice, it can be noticed that theory-based fields of activity are increasingly gaining relevance. It becomes apparent that in the social trend of academisation of skills, theoretical reflection and design practice must move closer in order to remain viable in the future. To push this approach, design education should promote theoretical reflection in project practice. Implications for the design process can be derived from various theoretical positions on the subject and a new view of one's activity can be gained. Used correctly, theory in education can help to anchor new processes and methods in the students' repertoire. In the first step, theory can provide a constructive way of finding problems, and then inspire the design process with images that break down the limits of the imagination. Finally, the integration of theory into design practice can help students create added value.

2.5.3 Research as an integral part of the design process

Designers cannot save the world on their own, but they do bear some responsibility for the challenges of our time. However, traditional design methods tend to focus on the form of things and are not designed to address the complexity of today's challenges. In response to this state of affairs, more and more fields in design are engaging in theory-based, scientific activities. To take advantage of this development, a stronger focus on the foundations of problem-solving should be established. Research can be cultivated as an integral part of the design at universities. Teaching methods for developing relevant research questions and documenting the results should play an important role in this. The focus on research could lead to more effective design solutions and an increase in the quality of designed objects.

3 CONCLUSION

With this research, we have tried to gain a general overview of what is essential for a future-oriented and yet resilient education. For design, it is crucial to respond to present changes in the economy and society. In this sense, cross-disciplinary approaches need to be encouraged. Collaborating with humanities and social sciences can be a catalyst for building a more resilient education. The knowledge gained here helps to stimulate reflection and thus gain a certain awareness of one's discipline. Last but not least, the combination of theory and practice will help design to strengthen its integrity as a relevant role in business and society.

Most of the results are interrelated to a certain extent and therefore cannot be considered isolated. They have been achieved in the field of design, but can also be applied to related disciplines such as architecture or others. Nevertheless, programme-specific evaluations are desirable. Each evaluation will increase the overall understanding of future-oriented and resilient education. As a result, intersections will emerge across programmes. These intersections are most interesting for a university as an overall organisation. Once this fertile common ground is explored, it can be used by the university as a driver for its future. A university-wide exchange then has a common basis for discussion – and it becomes a lot easier to find focused options for action.

CONSTANCE HOME-LAB AND OPEN ACCESS SENSORS

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Abstract. *Being able to perform experiments is an important skill for engineers. This leads to the necessity to include laboratory education even in online courses. In this talk, we report on two different ways how students' homes can be transformed into laboratories: The goals are teaching lab skills and adding empirical data to environmental discussions. The main focus is on the problem of obtaining reliable measurement results at home. The approach proved to be a possibility for open online lab courses. Results and problems are described.*

Keywords: Universities of Tomorrow, Engineering Education, Physics Laboratories, Open Access Sensor, Engineering Skills, Flipped Classroom, Team Coaching, Open Online Courses

1 INTRODUCTION

In recent years, an increased emphasis on teaching “skills” in engineering education is recommended [1] [2]. Many of those basic skills can easily be integrated into physics courses, due to the overall simplicity of some physics topics. Especially introductory physics labs can be tuned for a learning environment of many of these skills [3] [4]. How to teach “basics of measurements and scientific reporting” and “optimizing experimental setups”, for example, has been reported in [5] and in [6] respectively.

However, the lab classes always took place in the laboratory rooms at the universities. Therefore the questions arose, whether and how it is possible to ensure lab education in a purely online course, not only during the Corona crises but also as a possibility for Open Online Courses.

In order to solve this problem, the physics staff at the HTWG UAS Constance used their well-established method of Lab-Team-Coaching (LabTC) [7] and developed a 100% online course, which was called “Constance-Home-Lab”.

2 LAB-TEAM-COACHING LABTC

In order to understand the concept “Constance-Home-Lab”, it is helpful to first understand the underlying method of LabTC.

2.1 BASIC IDEAS OF LABTC

In order to give the possibility to learn how to run experiments, the set-ups and devices need not be complicated. Experiments that are easy to run proved to be more suited for teaching experimental methods. The main learning goal is not masked by complicated physics, which students at the undergraduate level very often find too difficult. Lecturer and student can focus on lab methods.

The second basic idea of LabTeamCoaching is based on the fact that students learn from mistakes, be it their own or from other people’s. An instructor should help to identify the mistakes made, of course, but it is always better if students find solutions themselves. Therefore LabTeamCoaching is designed as flipped classroom technique, where students first work alone, followed by teamwork, and finally meet with an instructor during a coaching session. [8]

2.2 PROCEDURE OF LABTC

Basically, LabTC consists of three phases (Fig. 1):

1. Running the experiment: learning alone or in a small group (dyad), simple physics, no instructor available.
2. Evaluating the results: learning in a team, complex questions, team discussions, no instructor.
3. Understanding and confirming the insights: coaching session, presenting result and discuss together with an instructor.

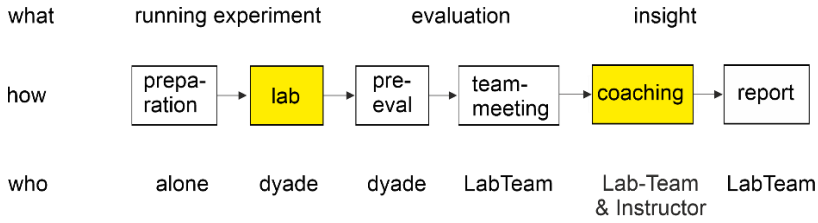

Figure 1: Phases in LabTeamCoaching, yellow boxes: phases at the university

As can be seen in figure 1 for LabTC the students need to be at the university only during two phases (yellow): the work in the lab and the coaching session.

3 CONSTANCE-HOME-LAB

It was not so complicated to transform the idea of the above-mentioned approach into a fully online course. The coaching session was replaced by online video conferences. Experience with this type of tool is reported in many other places and will therefore not be discussed here. Students were assigned to groups of six each. Because they could not meet face-to-face they were given the possibility to use online tools for their interaction.

3.1 REAL EXPERIMENTS AT STUDENTS' HOMES

Some ideas tended to have university staff perform experiments at the universities and send the data to the students. Others proposed to use computer-simulated experiments. Both suggestions didn't fulfill the requirements as they didn't allow for "making real mistakes". Over the past few years, we have found that an important skill for engineers is to be able to deal with real mistakes in a meaningful way. Therefore it was decided to perform "real experiments" also in online courses.

The problem was to find suitable experiments. They needed to be simple, to be run at home, but complex enough to train engineering skills. And of course, it should be possible to "do things wrong".

3.2 EQUIPMENT

As has been pointed out in LabTC, the experiments, set-ups, and devices need not be complicated. Therefore the focus was on finding lab experiments where students have easy access to all needed gear and equipment. Since the treatment of uncertainties is an important learning goal, measurement equipment was requested, where students could easily estimate the measuring tool's uncertainty. Thus some of the sensors in mobile phones were not suitable.

The measurement equipment chosen were:

- Meter rule,
- Stopwatch (mobile phone), and
- Kitchen scale.

The experimental setup itself required only common household items, such as paper, scissors, string, or glue. Additionally, the objects to be measured could be chosen at will. Many different things were measured, from hammers and musical instruments to bottles and handbags. Just what the students found at home.

3.3 EXPERIMENTS & LEARNING GOALS

Choosing from a variety of possible experiments, two proved to be particularly valuable for reaching the desired goals:

- Moment of inertia

  Finding a body's moment of inertia by using it as a pendulum. Students choose an object, suspend it, and make it swing. The objects chosen by all team-members are approved by the lecturer, in order to obtain varying results. Students measure the pendulum duration and length, and the mass of the body. While the measurement task is quite simple, it nevertheless offers many possibilities to train skills, especially during the evaluation phase.

- Coefficient of drag

  Students make paper hats, drop them from different heights and measure the duration until the hat hits the ground. Students are completely free to choose size, shape and heights. The experiment's focus is on drawing graphics that help other people understand the results.

With these experiments a few engineering skills are addressed:

- Design and implement measurement setups.
- Evaluate uncertainties of measuring equipment.
- Find sources of errors and mistakes (not uncertainties) and deal with them.
- Write reports and technical documentation.
- Improve an experimental setup based on an uncertainty evaluation.
- Enhanced dimensional analysis to create a theory for an experiment.
- Use of dimensionless constants.
- Create good graphs.

3.4 RUNNING EXPERIMENTS AND EVALUATION OF DATA

All students in the course performed an experiment at home, by themselves. They noted the measured values, did all necessary calculations, and tried to understand their result. In a second step, the six members of the Lab-team met, using a web-conference tool. They compared their results and tried to explain the differences. They prepared a presentation for the coaching session. For this step, they needed to use most of the above-mentioned skills. It was expected that the team members should be able to help each other in understanding and solving the tasks.

During the coaching session, the team and the instructor focused on the questions that had remained open. The main goal for the instructor was to find where a lack of insight existed. This was particularly difficult in the online meeting. Nevertheless, most teams seemed to have reached the desired goal.

In the last step, the students wrote a report. It consisted of two parts. The team report focused on fundamental questions all experiments had in common. It also tried to find answers to why results may have varied from student to student. An important topic could also be how an experiment can be improved, or whether it is possible to obtain a theoretical understanding. The individual part mainly contained all information about the student's experiment, such as pictures of the setup, measurement data, and performed calculations.

4 RESULTS

These Constance-Home-Lab experiment classes were held for three consecutive terms from October 2019 until July 2021. A total of over 300 students took part.

4.1 ACHIEVED GOALS

The team reports showed that all teams have achieved the intended goals. Thus chances are good that at least some of the students have improved their skills, as intended. One of the skills, evaluation of complicated uncertainties and improving experimental setup, was tested in the final exam. It proved to be the problem with the best average score in the test. This is a hint that the goal of training lab skills can be achieved with the mentioned method. Further evaluations were not performed.

4.2 STUDENTS EVALUATION

A students' survey was conducted at the end of the term, after the examinations. We wanted to find out, how students evaluated the course with regard to performing experiments at home. The physical contents and the skills learned were not of interest. Rather the feasibility, the access to the devices needed, and the motivation for running home experiments were addressed.

Students were asked to rate nine different statements, using a question-response system. They could choose from "totally agree" to "totally disagree" in a division of six steps.

Figure 2: Students response on Home-Lab

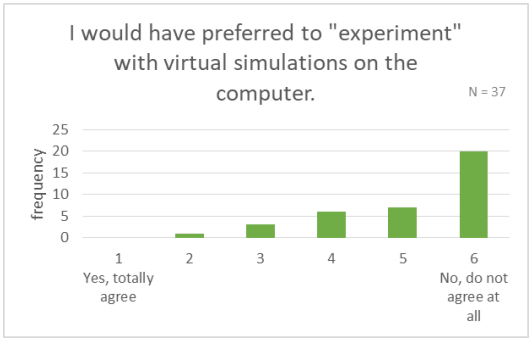

Figure 3: Desire to virtual Lab

An overwhelming majority of the students appreciated having had the chance to do experiments at home. They also strongly rejected "simulated experiments" (Fig. 2 and Fig. 3). Obviously, only a few problems were encountered in finding the necessary equipment, while running the experiments were more challenging (Fig. 4 and Fig. 5)

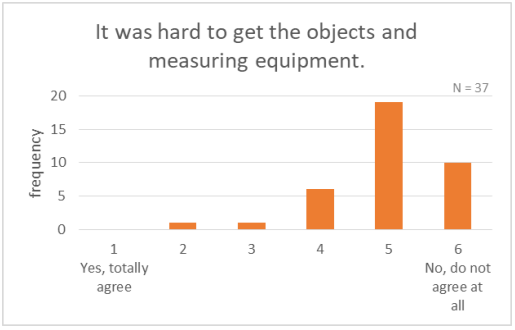

Figure 4: Difficulty in getting equipment

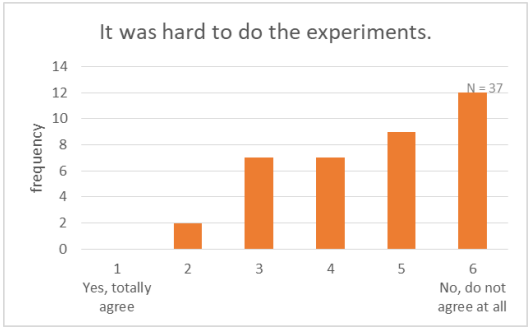

Figure 5: Difficulty in running experiment

The other points revealed that students judged the effort for the course as high or even too high. The main problem was writing the report, which in the students' view needed too much time. Nevertheless, over 70% strongly or totally agreed that they had learned something during the home-lab-course.

4.3 STAFF EVALUATION

It was not a problem to replace the university experiments with experiments run at home. In particular, “making things wrong” happened even more often, because there were no pre-setup devices. In most cases, the students’ setups met all the requirements of a "good experiment". However, it seems students put a lot more effort into this setup phase than we had expected.

The online discussions in web conferences did not have the compact form and were less targeted than face-to-face meetings in university rooms. Staff regarded this as the biggest disadvantage of the online labs. In particular, the necessity of post-processing the reports became a considerable additional workload for both students and teachers.

5 EXTENDING THE IDEA: OPEN ACCES SENSORS

Students had the idea to build up a sensor pool for the entire university. They wanted to obtain reliable data, especially in the area of environmental questions. Thus they applied for funding, which was granted by the university. Not only because the Constance-Home-Lab had proven that students can design good experiments on their own and perform meaningful measurements.

Thus, in cooperation with students and physics staff, a lending system was set up that enables all members of the university to borrow environmental sensors without much bureaucratic effort. The physics staff also offers the opportunity to discuss measurement setups and results and draw scientific conclusions.

Today over 15 sensors are on the list. They range from power meters to infrared cameras. However, up to now, not very many students have used this possibility. Hopefully, this offer will see more demand once students are back on campus in the coming terms.

6 CONCLUSIONS

Constance-Home-Lab is a possibility to transfer “real experiments” to student homes. It can therefore also be used for pure online courses. Finding suited experiments is the most crucial part. The setups strongly depend on the desired learning goals.

Surprisingly the main problem with the method did not arise in performing good experiments. Instead, it seems online coaching sessions are less efficient compared to face-to-face meetings. This should be evaluated in a further step.

The Open Sensor System has not yet reached enough students. Those who used sensors from the list appreciated the possibility to borrow advanced measurement equipment. It is, therefore, necessary to better inform all university members.

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SHARE KNOWLEDGE AND INCREASE INTERDISCIPLINARITY AT UNIVERSITIES - TWO INNOVATIVE BUT TOTALLY DIFFERENT CASE STUDIES

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Abstract. *Education at universities has undergone a massive change recently. Interdisciplinarity is taking centre stage - at the same time, a reduction in mobility is taking place because of the worldwide restrictions due to Covid 19 in order to save resources.*

Keywords: Universities of Tomorrow, Digital Education Platform, International, Interdisciplinary, Digitized, MOOC´s

1 INTRODUCTION

The following paper presents two innovative teaching formats: The first is the cross-faculty Open Innovation Lab at the Konstanz University of Applied Sciences (HTWG) - a makerspace with digitally controlled production machines - in which students are to learn lifelong learning in order to acquire the necessary skills for an agile and digitized working world. On the other hand, an international teaching platform is presented, on which teachers have jointly developed and realized a comprehensive and timeless textbook and now make a collection of MOOC´s , tutorials, lectures, and workshops available on the Internet by all for all.

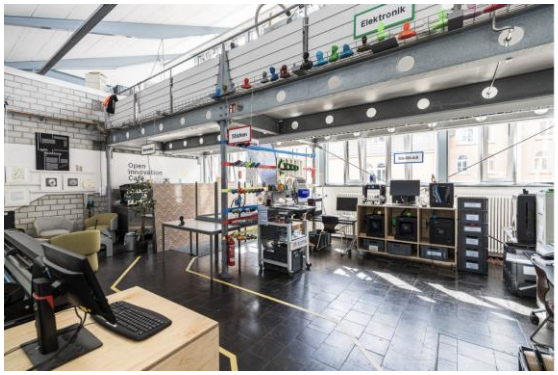
2 OPEN INNOVATION LAB HTWG KONSTANZ

2.1 AN INTERDISCIPLINARY SPACE

The Open Innovation Lab (OIL) is a laboratory at HTWG Konstanz that is continuously being expanded. It is oriented towards so-called "Makerspaces" and "Fablabs", i.e., publicly accessible, modern do-it-yourself workshops. It provides university members with digital tools. They can use them to creatively and individually develop, test, and manufacture new products. The OIL's technical infrastructure consists of 3D scanners and printers, machines for CNC manufacturing, and augmented and virtual reality systems. It is modeled on the so-called "innovation rooms" operated by some large companies to bring innovative products to market quickly through design-thinking methods and prototyping.

With its various faculties, HWTG Konstanz offers a wide range of specializations. Thus, there are technical faculties, business chairs, and a design faculty. One of the most important values of the relatively small university is interdisciplinarity. And this value "interdisciplinarity" also became one of the main ideas of the Open Innovation Lab. The Lab serves as an interface for all faculties of the university. Projects, courses, and thesis are offered across faculty boundaries.

Important for the Lab are not only the technical possibilities of digital production but also the communication beyond the boundaries of the faculties. To discuss, tinker and, live with and for each other with a small coffee corner. To discuss outside the box is one of the most important skills of the students of the OIL. To speak a common language.



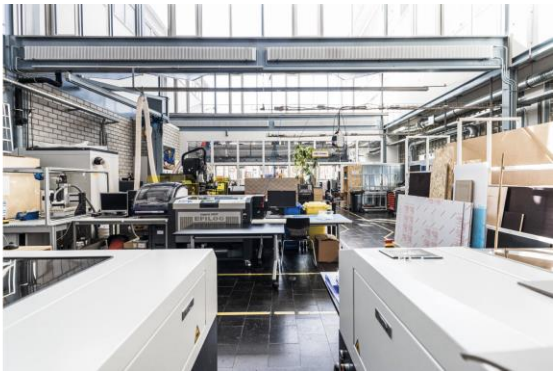


Figure 1: Open Innovation Lab, HTWG Konstanz (photo © Christian Witt)

2.2 Lifelong learning

There are a large number of computerized machines that cover a wide range of possibilities for the interests of students from different faculties - All this can be learned in the OIL under guidance.

The first steps of inventing devices are often inspired by a YouTube tutorial or by downloading a 3D printing file...

This imitation and copying from the "masters" on the internet probably has a higher value than accepted in university teaching. After all, these role models show what is possible with new technologies - by this I mean digitalization, artificial intelligence, DIY, digital production, etc which closely resembles the teaching formats of a traditional master class at an artistic academy.

Nevertheless, the core question of lifelong learning thus emerges: If I can produce everything and obtain all the knowledge I need from the internet, what am I doing? This is a crucial question for the coming generation, from which much creativity, spontaneity and, agility will be demanded - often named as the skills of the 21st century.

3 ATLAS OF DIGITAL ARCHITECTURE

3.1 ALTAS

The ak.ai is a working group of German-speaking professors of Computer-aided Design in the field of architecture who meet and exchange ideas on a regular basis.

Together, the Atlas of Digital Architecture has been published as a powerful textbook - divided into six parts and offering an orientation to the myriad ways computers are being used in architecture today, such as 3D modeling and CAD; rendering and visualization; scripting, typography, text, and code; digital fabrication and model making; GIS, BIM, simulation, and Big Data and machine learning, to name just these. Throughout, the Atlas provides both a historical perspective and a conceptual outlook to convey a sense of continuity between past, present, and future; and going beyond the confines of the traditional textbook, it also postulates a theoretical framework for architecture in the 21st century.

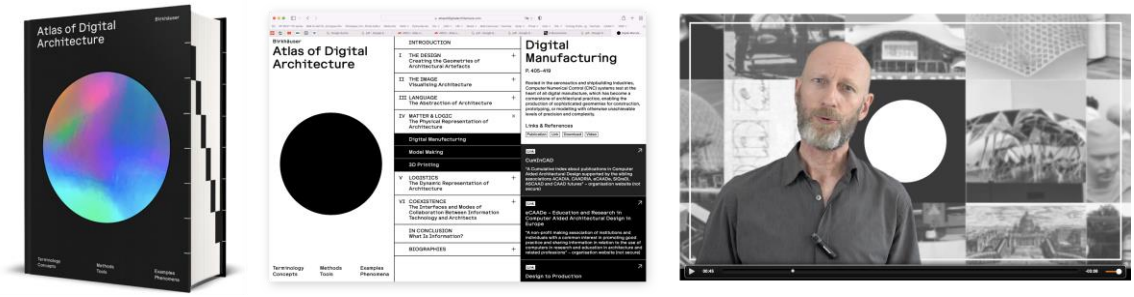


Figure 2: Atlas of Digital Architecture, Book, Website and MOOC

3.2 MOOC´S, TUTORIALS AND LECTURES

Last year, due to the Corona pandemic, teaching took place online at most universities - a teaching format that worked extremely well for some courses. Even though everyone involved is aware that this cannot replace regular face-to-face teaching, the Atlas editors came up with the idea of adding a digital platform to the basic idea of the textbook: to take the knowledge of the respective lecturers beyond the boundaries of the university and share it with each other - and thus share expertise between universities, to better connect universities across national borders and to offer students a broader, more precise range of expertise.

While the book should bring the timeless, abstract knowledge of the experts into the students' studios, direct interaction in the form of a lecture or the practical and concrete application of a software or a 3D printer can each be transported in video format on an Internet platform.

Even more concrete is the direct interaction in the 1:1 conversation, which through video telephony and the possibility of screen transmission and control sovereignly transcends the boundaries of universities and countries. The goal is a joint platform development that, with the help of virtualization, enables higher-quality teaching that is more individually tailored to the needs of the diverse interests of the students, without increasing the load on the teaching load by increasing the time spent by the teachers. The platform should include quality-assured video lectures and tutorials, coordinate cross-university courses, and also personal online consultations with the appropriate expert from another university.

3.3 STEP ONE REALIZATION: MOOC´S

The MOOC Atlas of Digital Architecture then understands itself as a companion to this engaging textbook. The authors teach at leading universities throughout the German-speaking world and are experienced educators and researchers each in their own right. This MOOC brings their expertise together and the Atlas of Digital Architecture as the companion textbook puts their individual inputs into a coherent context. Students can use the book and the MOOC in combination for studying the subjects in depth.

There is a website accompanying the book which provides additional links to references, publications, further reading, etc. The MOOC lectures will be made available as links as well, and can thus benefit from the traffic to the website. The idea is that the book and the MOOC complement and strengthen one another. The fact that the book was a collective effort by so many different authors from different universities should lead to a high impact factor also for the MOOC.

An important conceptual idea is that the MOOC, just as the book, isn't conceived as a monolith, but as a collection of individual modules. It is thus possible to selectively choose only parts of the MOOC to be integrated into various teaching offerings at different universities.

Modularity is very much like the web and of the way students pick and choose what they study online. We expect that the fact that it's possible to start in the middle or to only study the parts that interest them will make the MOOC popular with students.

While the content of this MOOC far exceeds what could be covered in a lecture in a single semester, the innovative concept here is that the MOOC, just as the Atlas, consists of individual, independent modules.

Since they do not build upon each other, they can be arranged in any sequence and can thus be integrated into existing lectures and seminars at will.

For example, a seminar on Architectural representation could make completing the lectures on Rendering and Visualization part of its required course material. A class on Sustainable Design might include the modules on BIM and Simulation, etc. For learning control, the individual lectures will have separate tests (to earn ‘badges’).

REFERENCES

[1] Website Open Innovation Lab: **http://www.oil.htwg-konstanz.de**

[2] Editors: Ludger Hovestadt, Urs Hirschberg, Oliver Fritz, 2020, **Atlas of Digital Architecture: Terminology, Concepts, Methods, Tools, Examples, Phenomena**, Birkhäuser; 1. Edition