ETH zürich

Learning and Teaching Fair 2020 Guide

Proceedings of the
Learning and Teaching Fair 2020

CHANGING STUDENTS'
PERSPECTIVES

LEARNING WITH
DIGITAL TOOLS

FOSTERING NON-DISCIPLINARY
COMPETENCES

TEACHING IN AN
INTERDISCIPLINARY SETTING

EXPLORING NEW WAYS TO
TEACHING AND LEARNING

LEARNING AND TEACHING FAIR

About the Learning and Teaching Fair 2020

This year's Learning and Teaching Fair at ETH Zurich will be a virtual exhibition by means of a website. The Fair will showcase the richness and diversity of teaching and learning at ETH by presenting a wide range of teaching and learning projects. Building on the well-established annual celebration of teaching innovation at Innovedum events, the Learning and Teaching Fair goes further by focusing on education at ETH itself. Its intention is to foster exchange on the topic of student learning via contributions from ETH teaching staff and students. The Learning and Teaching Fair is a vehicle for discussion, feedback and inspiration among the ETH teaching and learning community.

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ALEEDSA: an Augmented LEarning Experience Data Science App

ALEEDSA (Augmented LEarning Data Science App) is a system to perform collaborative and interactive data science education with augmented reality. ALEEDSA promotes collaborative learning of data science through an interactive experience to pairs of students, who need to solve data science problems with a focus on machine learning model interpretability.

ALEEDSA (Augmented LEarning Experience Data Science App)[1] is a system promoting a collaborative and interactive data science experience with immersive augmented reality. Using ALEEDSA, pairs of students collaborate to solve a real-world data science problem with a focus on machine learning model interpretability.

ALEEDSA comprises both classical interfaces (i.e., laptops) and augmented reality devices (Microsoft HoloLens). During its immersive experience students face some of the typical challenges of data science projects in the practice. They solve a sequence of exercises of increasing complexity, and they are provided with live feedback of their performance. ALEEDSA is designed to promote active collaboration and situated learning: students share and manipulate 3D holograms in real-time and interact with selected elements in the physical space.

1) Andrea Ferrario, Raphael Weibel, and Stefan Feuerriegel. 2020. ALEEDSA: Augmented Reality for Interactive Machine Learning. In Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems (CHI EA '20), Association for Computing Machinery, New York, NY, USA, 1–8. DOI:https://doi.org/10.1145/3334480.3382937

ALEEDSA can be used to design learning environments for data science education that make use of immersive technologies. It supports the development of interdisciplinary skills that can be used by the students in their future professional endeavours. In particular, it is designed with a focus on the collaboration of students with different educational backgrounds and approaches to the complexity of real-world data science problems.

In an ALEEDSA early user study, 67% of the subjects reported that interactive visualizations in augmented reality enable a better understanding of data; moreover 86% of participants argued that augmented reality can support machine learning activities for non-experts. In 2021, ALEEDSA will be embedded into existing data science lectures at the department of Management, Technology and Economics (MTEC) at ETH.

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Change in students' attitudes of learning physics in the live sciences

In this project, we address the question to what extent the redesigned physics lecture induces changes in the students' attitudes of learning physics and how well we succeed in making the students think like a physicist.

For students pursuing careers in the life sciences, the concepts of physics are increasingly becoming important. Physics-based technological tools now being integrated throughout biological and pharmaceutical research, it is essential for future graduates in these disciplines to fully understand the underlying physics concepts.

Almost all undergraduate curricula at ETH Zurich include lectures in physics, which are taught by faculty from the Physics Department. Apart from presenting the basic concepts in physics, one of the major goals of these service lectures consists in training students to view and understand the world in a scientific way by applying coherent logical and mathematical methods. However, students with non-physics majors often lack a motivational incentive in studying physics and they struggle in viewing physics as a valuable subject for their own discipline. To overcome these motivational issues, we have completely redesigned a compulsory first year introductory physics lecture offered to students in biology and in pharmaceutical sciences. This new design relies on well-established principles that have been worked out by the Introductory Physics for Life Sciences IPLS initiative[1].

1) Meredith, D. & Redish, E. (2013). Reinventing physics for life-sciences majors. Physics Today, 66(7), 38-43.
2) Adams, W.K., et al. (2006). New instrument for measuring student beliefs about physics and learning physics: The Colorado Learning Attitudes about Science Survey, Phys. Rev. ST Phys. Educ. Res. 2, 010101.

Based on the overarching learning goal that students should be able to identify, describe and solve physical problems in their own discipline, physics concepts are now linked to a wide range of concrete examples taken from biology, medicine and chemistry. By making physics more accessible, we hope that students change their attitudes and beliefs of learning physics.

Assessing views and opinions of students, however, turns out to be a challenging task that it is not covered by typical performance evaluations, such as exams and in-class activities. To that end, we are relying on CLASS, the "Colorado Learning Attitudes about Science Survey"[2]. CLASS is a common and well-established instrument to probe the students' beliefs about physics and about learning physics. We have administered CLASS as a pretest at the beginning of the physics lecture and as a posttest at the end. By contrasting both results, we are able to show evidence for a change of students' attitudes.

Based on results from the literature[3] and on students' active engagement, we expected positive results. Former studies already showed that, especially in large classes and with non-physics majors, the initial scores in CLASS tend to deteriorate considerably [2, 4]. In our case, with more or less unchanged attitudes, we could not replicate these findings. The transition period of only 12 weeks might have been too short for gaining more conclusive results. Our results, however, serve as a good baseline when redesigning further physics lectures for the life sciences.

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3) Crouch, C.H., et al. (2018). Life science students' attitudes, interest, and performance in introductory physics for life sciences (IPLS): An exploratory study, Phys. Rev. ST Phys. Educ. Res. 14, 010111.
4) Madsen, A., et al. (2015). How physics instruction impacts students' beliefs about learning physics: A meta-analysis of 24 studies, Phys. Rev. ST Phys. Educ. Res. 11, 010115.

Code Expert: A ready-to-use platform for teaching programming courses

Code Expert is a worry-free and platform independent online IDE that allows thousands of students at ETH Zürich to work on open programming tasks in exercises and exams.

Programming skills became fundamental for students in a wide area of fields. The acquisition of these skills is fostered by hands-on programming experience and learning from mistakes. To support this, it is crucial that students are provided with real-time feedback from automated assessment mechanisms, combined with personalized feedback from assistants.

To meet the increasing demand for programming courses, the Department of Computer Science is developing suitable tools, which are also available to lecturers from other study programs. One such tool is Code Expert: an ETH-managed programming and assessment platform that enables lecturers to quickly set up individualized programming courses and exams on various levels. Code Expert enables students to write code without technical barriers, thanks to a pre-configured and platform-independent online development environment, allowing them to maximize time on task.

For lecturers, Code Expert provides a platform to prepare and deliver tasks to an entire course. For every task, automatically determined marks and feedback can be extended by letting assistants manually review the submissions as well as providing students with fast and high-quality feedback. Code Expert also offers gamification features to

increase motivation and provide diligent students with additional resources. Thanks to its scalability and reliability, Code Expert is also in use for summative exams. For researchers, the Code Expert platform allows deep insights into individual learning processes. We expect this to provide answers in the field of learning sciences and methodologies. For example, we are interested in finding early indicators for student's performance and in learning more about feedback and its impact on learning success.

Code Expert is in use for 4 years now, and has 8900 registered students in 46 courses, who submitted almost 300k exercises. One of these courses is Computer Science (Basisjahr D-MATH/PHYS), where Malte Schwerhoff and Felix Friedrich teach foundations, as well as a concrete programming language. Students obtain experience points from weekly exercises, which unlock challenging bonus exercises that combine topics from several weeks. Code Expert analytics and students' feedback suggest that this is highly motivating. We encourage teamwork on the conceptual level, but use automated tools to ensure that students ultimately submit their own solution. To keep the course on track, we use Code Expert analytics, e.g. to see if exercise participation drops or if assistants provide feedback on time. Both lecturers also use Code Expert for hands-on courses (Engineering Tools at D-MAVT) with a much smaller audience and a strong focus on group work. These courses are short, and the high time on task Code Expert enables is crucial here.


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Collective performance assessments to promote a collaborative learning experience for students

We have designed a novel performance assessment that seems to strongly stimulate collaboration among students and help them practicing higher-order cognitive skills in the learning process. The positive feedback received from students is encouraging and suggests that taking part in a collaborative learning environment has a positive effect on knowledge's consolidation.

Traditional teaching methods are often based on transmitting concepts through frontal lectures. Such strategy is strongly focused on teaching technical knowledge rather than promoting the development of personal and social competences. To maximize the development of high order skills, teaching instructors can promote a collaborative learning environment by creating together with the students an open and collective atmosphere. We believe that such atmosphere encourages freedom of thought instead of promoting conformity in the learning process. In our course, we established a collaborative learning environment by replacing typical individual assessments with a collective evaluation of the performance at the classroom level. In this format, students are encouraged to collaborate with each other and with the teaching instructors to construct together the knowledge necessary to reach the learning goals of the course.

The approach we have developed constitutes, to the best of our knowledge, a novel assessment strategy at ETH Zurich.

To prepare the students for the in-class assignment, teaching instructors ask the students to familiarize with the topic of the assignment by providing selected reading material a week in advance. At the beginning of the lecture, the students are encouraged to discuss the topic with their peers. Then, two students are randomly selected to present the topic to the entire classroom. The presentation is the starting point of a discussion round that is mediated by the teaching instructors. All students are encouraged to ask questions and complement the explanation of the topic. These rounds of discussion promote a strong collaborative atmosphere in the class. At the end of the class, the collective performance of the classroom is discussed and the grade is issued based on the achievements of the entire class towards the learning objectives of the course.

The open communication channels established with the students combined with the detailed information about the learning expectations for the collective performance assessment and the detailed feedback on the classroom performance have strongly engaged the students in the learning process. The strong engagement and enthusiasm demonstrated by the students has been considered as a qualitative indication of the benefits imparted by promoting a collective atmosphere in the classroom. Anonymous feedback collected through the Moodle platform indicated that the assessment method employed might have led to a more efficient consolidation of the knowledge. We believe that this type of performance assessment encourage a collaborative atmosphere among the students enrolled in the course. Rather than competing with each other to obtain the highest grades, the students were highly motivated to establish a cooperation with the teaching instructors and their colleagues so as to build together the knowledge required to fulfill the learning goals.

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Energy and climate systems III (HS 2019 & HS 2020)

The master course ‘Energy and climate systems III – climate responsive design’ addresses passive and active design strategies and methods to design sustainable and energy efficient buildings that are responsive to local climate and site conditions. The course focuses on a learning-by-doing approach using state-of-the-art computational tools.

This course teaches architecture and building engineering students necessary skills and tools for climate responsive, sustainable building designs. It includes microclimate analyses of the building site for utilizing local renewable energy potentials and for understanding architectural design implications that the site has on comfort and energy efficiency. Passive and active design approaches are taught, as well as simplified calculation and simulation methods. Students will become familiar with a climate focused and energy-responsible design process and will acquire the skills for using computational tools to apply these principles in their building design projects. The major teaching innovation of this course is the learning-by-doing approach, which fosters a tight integration between exercises and classical input lectures. This is especially important in practice-oriented domains such as architecture and building engineering. Classical input lectures outline the physical mechanisms and related design strategies for comfortable and energy efficient buildings in different climate zones. Starting from

HS 2020, these exercises will also include "Hive", which is an ETH Innovedum-funded software tool developed by the chair of Architecture and Building Systems (A/S) for integrated building energy systems design in teaching. In this course, we teach tangible concepts of energy efficiency and systems integration to architecture and engineering students. Via interactive exercise sessions and design work, students can intuitively absorb and apply knowledge. In such an applied domain, we experience that a multi-faceted teaching format (combination of input lectures, software exercises, applied design work) proves to be highly effective for educating the next generation of environmentally conscious building designers. More specifically, we promote student learning by providing pre-study material (courses, references, tutorial videos, software templates, etc.). Furthermore, we divide the interactive exercise sessions in generally two parts: first, a walkthrough of the exercise material and software to use, followed by an open session where students independently work on the exercises (in groups) under the guidance of teachers and assistants. "Hive" will thereby play a central role. To identify major shortcomings and potential improvements of the teaching format, as well as understanding student preferences in learning, several feedback sessions and surveys are conducted throughout the semester.

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Engaging physics tutoring: Didactical tool-box for your exercise class

In our project we develop a didactical tool-box of materials and activities for teaching assistants supervising exercise sessions on Physics I for Medical Students. Materials for 14 classes will be available in the form of an interactive PolyBook web-platform and promoted at a hands-on training course specifically designed for physics teaching assistants.

How can I improve the learning success in my physics exercise class? Which strategies can help me to step out of the standard exercise-solving automatism? How can I "hook and hold" my students? In our project we try to answer these questions by developing a didactical tool-box of activities for physics teaching assistants (TA).

The idea for this project arose from our observation that in practice many TAs struggle to implement techniques which they have learnt in general basic-teaching courses. Furthermore, the time it takes to prepare an engaging, innovative lesson usually exceeds the preparation time which TAs can invest in addition to further duties like correcting homework and managing their class.

The materials developed in this project will include examples of implementations of teaching techniques for the specific case of 14 exercise sessions on Physics I for Medical

Students. This will clarify and reinforce the link between didactical methods and their realization in practice. Our toolbox consists of concept questions, summarizing organizers and case-based calculation examples - all of them combined with ideas on how to implement it in class. Additionally, ideas for the "hit" of each lesson are provided, which can be real-life applications and phenomena or engaging games, that involve the students emotionally and foster their active thinking in order to help them to develop higher-level competences.

With our didactical toolbox full of materials and ideas we would like to support TAs in preparing high-quality exercise sessions for their class which go beyond frontal exercise solving and which both students and the teacher can enjoy together. All materials will be available in the form of an interactive PolyBook platform. Additionally, we will conduct a hands-on training course specifically designed for physics TAs in which we will promote our toolbox and discuss possible ways of using it. Like this we hope to spark a creative curiosity between the TAs helping them to try out new techniques and activities in their lessons.

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Hard facts for the media: "Research, collaborate, communicate" for BSc students

The BSc capstone course “Environmental Systems Seminar” allows students to acquire competences in joint literature research and writing, in reviewing the work of other groups and – supported by media experts – in creating media outputs for different target groups.

The BSC in Environmental Sciences qualifies its graduates, among other things, to formulate research questions, to acquire the information necessary to answer them independently or in interdisciplinary teamwork, and to communicate the results to a broad range of audiences. The capstone course “Environmental Systems Seminar” in the 6th semester offers students the opportunity to develop these skills further.

During the first seven weeks and guided by PhD students from the department, they: 1) Develop an interdisciplinary research question on a given topic (e.g. “Microplastics” or “Forest and Global Climate Change”) in groups of 6 students from different specializations (BSc Majors) 2) Conduct individual literature research on an aspect of the research question related to their specialisation and add the relevant publications to their group literature list in Mendeley including personal comments; 3) Create a summary with 5 key papers, making use of Mendeley for correct citation; 4) Compile the text elements during a group meeting into a scientific factsheet with an abstract and a bibliography of 20-30 references; 5) Check two abstracts from other groups to see whether abstract title and text aligns with the research question and if the key statements made are

backed by the cited literature 6) Discuss results in 2x30-minute live feedback sessions and finalize factsheets including inputs from colleagues and PhD students.

In the second half of the semester the students - in groups of 3 or 6 - create a media product (blog, infographics or short video) which summarizes the found facts for a self-chosen target audience (e.g. news consumers, K12 students, special consumer groups, politicians, ..). This media production phase begins with workshops where media experts introduce the students to the workflows and necessary tools, and the groups produce prototypes. The student groups then produce first versions within 4 weeks, feedbacked on their way by the media experts. These products are subsequently critically assessed by their student colleagues in another live feedback event, both for factual accuracy and suitability for the target audience. The revised media products are presented on the web for the final event, a Pecha-Kucha tournament in which the groups advertise their work in a very condensed form.

Our course format (editorial meetings, feedback rounds) ensures that participants have to delve deeper into the writings of both their group members and that of other groups, a key success factor when publishing across disciplines. By concentrating on the factsheets first and working on the media products afterwards, the students could present the media experts with a solid scientific basis to help them start the translation of scientific information. Finally, the 2020 edition of the course profited largely from the switch to the online format: it was possible to run feedback sessions with various combinations of students (group-puzzles) in breakout-sessions without the necessity to move almost 100 students across rooms. Those parts of the course will thus remain online even after getting "back to normal".

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Implementing productive failure in a course on algorithms and data structures

We chose to implement productive failure, an innovative learning paradigm, in a course on algorithms and data structures.

In the course Informatik II at D-BAUG, students learn the algorithmic, computational thinking and supplementary foundations through instruction in algorithms and data structures. This topic is an important component of tertiary computer science instruction, but is also generally considered difficult for students; in universities around the world, dropout and failure rates are reported to be higher than in courses on comparable topics that require similar background knowledge. Therefore, we believe that innovative instruction in the course has the potential to significantly improve student learning outcomes.

Productive failure (PF) is a learning paradigm invented and studied by ETHZ Professor Manu Kapur (D-GESS). PF belongs to the family of explore-then-explain approaches that promote active student engagement for knowledge generation. During PF activities, students are given challenging problems before they receive instruction from their teachers. Students are explicitly not expected to solve the problems successfully, but during the course of their attempt, they learn deep features of the problem domain that may be helpful for retention and transfer learning. PF has been studied extensively and shown to be helpful across a variety of domains.

We held three productive failure sessions in Informatik II during the Spring 2020 semester, each corresponding to a different part of the course material and each targeted at

a very fundamental and important principle, to be introduced in the lectures following the respective session. The first such session was held in physical presence, but due to the COVID-19 pandemic, the second and the third one had to be conducted online. The sessions were performed in several groups of about twenty students. Students were given a link to a difficult algorithms problem on Code Expert, an ETH-developed programming platform that allows students to develop and submit computer code. During the sessions, the guidance offered to students was limited to clarifying the problem, technical assistance, and help with computer programming syntax. Only during subsequent course lectures were students shown how to solve the problem correctly.

Since the instruction offered to students during the spring semester was very different than during previous semesters, it is difficult to find fair methods to compare this semester's learning outcomes with previous semesters' outcomes. Therefore, in order to assess the effect of our experiment, we asked students to answer two different surveys about their PF experience. The results of these surveys were similar to some other surveys that have been conducted for PF experiments in other academic subjects. As expected, students reported that they had insufficient knowledge to complete the task given, but also that the task intrigued them and made them want to know more. The survey results were, however, not uniformly positive, as a number of students (5 out of 16) that answered our second survey reported that they did not believe that the PF sessions were helpful for them.

We found that moving the PF session to an online setting was not a serious liability, as students are expected to conduct their work without much instructor interaction. This way, the PF sessions can scale to a larger number of students.

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Improving students' data science competencies – experiences from D-USYS

Data science competencies are important in research and teaching at ETH. However, few departments offer a coordinated data science education. With this project, we identified opportunities to better integrate data science competencies in the D-USYS master curriculum. Our participatory approach could guide other departments towards an improved data science education.

Despite the growing importance of data science competencies, a coordinated approach to integrating these competencies in the curriculum is missing, leading to a lack of a broader perspective and lost synergies. Our project aims to improve data science education in the curriculum of the Department of Environmental Systems Sciences (D-USYS).

As a first step, we identified key data science competencies and mapped the existing expertise within the department. To do so, we conducted 17 semi-structured expert interviews with relevant researchers and lecturers. These interviews revealed that some approaches are specific to certain scientific fields, but the basic "data science workflow" is similar across disciplines. Thus, it seems sensible to create a joint course concept for all D-USYS master students where they first learn the most important

common methods and best practices, and then deepen their knowledge according to their scientific interests.

As a second step, we consolidated these findings in an interactive workshop involving more than 30 lecturers, researchers and students. Through this broad involvement of relevant stakeholders, we gained strong support from students and faculty for the idea of a department-wide course concept. We decided to offer an introductory course "Environmental Systems Data Science" in the fall semester, followed by major-specific "Applied Modules" in the spring semester as a long-term goal.

Finally, as a third step, the detailed learning objectives and contents of the course "Environmental Systems Data Science" are co-developed with three assistant professors based on the findings from the expert interviews. This innovative new course provides an overview of the most cutting-edge data science concepts (e.g. applications of machine learning) and illustrates best practices from environmental sciences (e.g. data preparation, version control). This course is offered as a pilot in the fall semester of 2020. In the future, "Applied Modules" could build on foundations laid in this course and enable students to gain hands-on experience with domain-specific methods.

This project is still on-going and we anticipate to be confronted with several challenges. We predict the main challenges will arise because 1.) students have heterogeneous backgrounds, 2.) learning success depends on how well the applied modules build on the competencies acquired in the intro course, and 3.) the course has high demands on the computer infrastructure due to large data volumes. To address these challenges, we will monitor the learning outcomes of both intro course and applied modules, continue to foster a dialogue between the lecturers, and provide guidance with the technical infrastructure.

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Edword – An online assignment feedback tool

The online assignment feedback tool Edword quantifiably improves the quality and efficiency of commentary and its uptake and measures previously unobserved aspects of learning. Following a pilot implemented in FS20, the tool is preferred over traditional feedback methods by 87% of the students.

Teachers' commentary to students' assignments is a fundamental element of instruction in almost any discipline whose knowledge can take written form. However, many aspects of students' uptake of this commentary remain unknown. Consequently, teachers face fundamental questions for which no ready answers are available: Which components of commentary are most helpful, and how are they most effectively delivered? How can students' uptake of commentary be optimized, and how can teachers' scarce time be most efficiently applied in providing commentary?

This presentation showcases Edword, an online assignment feedback tool that provides answers to these questions; it quantifiably improves the quality and efficiency of commentary and its uptake, and it measures previously unobserved aspects of learning. Students can upload assignments of any kind. Teachers can then add commentary to the assignments they have set. These comments can be written individually in the traditional way, but Edword also enables the rapid application of prewritten comments from comment sets. These comment sets can address any aspects of written work in

any discipline. They can be prepared by teachers working individually or shared between colleagues in teams, and they can be adjusted and augmented, so a comment set can evolve as individual comments are added and improved. The quality and level of detail that can be delivered within the time available for commenting on assignments is thus substantially increased.

When the student opens the commentary, the most important comments, selected by the teacher, are presented first and repeated comments bundled so that the student sees every instance of the same comment in an assignment. This allows the teacher to optimize individual students' uptake of their commentary. Edword also measures two aspects of students' uptake: the time given to each individual comment is automatically recorded, and the student gives one of three responses—helpful, neutral, or unhelpful—to each comment. These data are automatically collated by comment and assignment to provide a fine-grained evidence base for further adaptation of comment sets and commenting practice to the specific requirements of programs and disciplines.

Edword's suitability for use with UZH and ETH students was tested in a pilot project between February and May 2020. A group of four writing instructors at the UZH/ETH Language Center collaborated with ETH's LET to implement Edword with 167 students in 14 courses. The instructors created and shared comment sets containing over 350 specialized comments in all. The participating students were surveyed online about their experience with Edword at the end of their courses (response rate 32%). Some 87% said they preferred commentary via Edword over traditionally delivered comments.

Edword can be used to provide highly nuanced and sophisticated commentary for any kind of written assignment, and comment sets can be adapted to the demands of any discipline. The comment sets can be written centrally or developed collaboratively or individually, and the uptake of commentary is monitored in detail. Further test groups can demonstrate the range of contexts in which Edword is applicable.

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Individual coaching of student projects at large scale with PELE

The software enables the implementation of application-oriented and student-centered approaches with more interaction and personal feedback, physically in a classroom or completely online.

The Software PELE (Personal Electronic Learning Environment), part of the KITE-Award winning project in 2018, is being developed for 5 years at the department of computer science. The system organizes individual coaching of student projects with regular feedback even with large student cohorts of several hundred students. Fixed exercise groups can be replaced by dynamic and more personal ones to change the whole course towards student-centered personalized learning. During the Corona period, PELE was extended by an important element, which enables continuous distance tutoring with regular personal interaction.

We teach more than 1100 first semester natural science students in computer science, where they learn the basics of programming and data science by working on projects with real data. Depending on their previous knowledge, students first learn individually the basic knowledge with provided online tutorials, before they have to transfer the learned concepts into practice by solving small programing projects. In order to regularly discuss their individual results with a teaching assistant and to receive personal feedback, the students register in PELE for a personal one-to-one meeting of approx. 15 minutes every second week. On presentation day, teaching assistants call up the registered students in PELE, which connects them directly in a personal Zoom-Meeting room.

Analyses of learning time and motivation have shown that students learn more intensively and regularly when they have to present and discuss their individual project results regularly to a teaching assistant. At the same time, they build and expand their conceptual knowledge based on understanding, which proves to be more sustainable than superficially learned factual knowledge. Furthermore, misconceptions can be identified and clarified during the discussion. Students appreciate the fact that they can take control over their own learning process from the very beginning and can freely organize their learning time. For the teaching assistants, this form offers an ideal environment to expand important question technique and feedback skills. PELE also allows peer feedback, with teaching assistants and students evaluating each other. This information can be used by the instructor to monitor large courses.

At ETH, different scenarios have been developed for the use of PELE. The software proves to be very flexible and highly scalable in use, provided that sufficient rooms (virtual or physical) and teaching assistants are available. PELE is currently used in 12 different courses (at D-INFK, D-MATH, D-ITET) with more than 2200 students annually leading to approximately 10'000 formative assessments with personal feedback. Last autumn semester the first PELE-based course was held without weekly lecture and final exam. During the Corona period PELE was also used to discuss the final written end-of-semester test individually.

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Integrated Design Project and Studio Boltshauser (HS 2019)

The Integrated Design Project (IDP) of the Master program in Integrated Building Systems (MBS) combines students of Architecture and Engineering. The goal of this course is to train students to apply their theoretical knowledge in a lifelike scenario and to collaborate efficiently in an interdisciplinary team of planners.

The MBS program, introduced in 2014, links the fields of Architecture, Civil, Mechanical and Electrical Engineering, and Energy Sciences with the goal of training future interdisciplinary planners to deal with the challenges of reducing CO_2 emissions while promoting clean energy sources for the built environment. The focus of the IDP course lies on this interdisciplinary collaboration and integration of sustainable energy concepts and technologies, together with architectural concepts on the building and the urban scale. The course focuses on teaching and learning activities for functioning knowledge, thus on applying knowledge acquired in previous courses, designing innovative and realistic solutions, solving problems and evaluating proposals. It promotes problem- and case-based learning, where students are required to carry out their own solutions and present them to a wide range of audience. Furthermore, it promotes lifelong learning, through subjecting the students to real problems that they may face in practice in the future. Finally, working with state of the art tools helps increase the graduate student's value in the working market.

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Integrating transferable skills into an existing curriculum: the degree programme initiative in Geospatial Engineering

We present the process and documents for improved formation and consolidation of transferable skills throughout the entire BSc degree programme in Geospatial Engineering. It is characterized by low additional effort on the part of the lecturers, directly visible benefit for the students, and direct communication among the lecturers.

Graduates from a university need a broad range of competencies for a successful professional career. Most courses in a university programme focus on the formation of subject-related competencies. Students thus need to increase the awareness and level of social, personal and broader methodical competencies proactively by themselves e.g., through role models. The levels of proficiency may thus differ significantly within a cohort, and the graduates may not be aware of this proficiency even if it is strong.

We present the approach for improved formation and consolidation of transferable skills throughout the program which we implemented with a particular focus on feasibility under the typical temporal, structural and financial limitations of an academic programme. With support through an Innovedum initiative we have integrated the enhancement of competencies in argumentation, critical thinking, technical/scientific writing, visualisation, presentation, learning management, teamwork, and project management into the

Bachelor's programme in Geospatial Engineering without changing the structure of the existing curriculum or assigning different lecturers. The pillars of the approach were (i) stakeholder participation from the very beginning, (ii) transparency, (iii) networking and communication, and (iv) supporting material for both students and lecturers.

Starting with the qualification profile we mapped the landscape of transferable skills within the curriculum by bilateral interviews with all lecturers, identifying which skills were already fostered, assessed or required in which courses, which teaching methods and materials were used, and which skills were considered necessary at graduation. We then made a catalogue of explicit learning objectives, developed a hierarchical set of short documents for in-class and self-study use, and created an interactive web-tool for visualisation of transferable skills across the curriculum. The stakeholders (lecturers, students, and potential employers) participated through workshops. Finally, we associated the learning outcomes with the existing courses and recorded the commitment of the lecturers by further bilateral meetings. Monthly brown bag meetings were established for enhancing the communication among the lecturers, providing low-threshold training by invited external experts, and discussing in-class examples.

Success factors of the approach are the low additional effort on the part of the lecturers (facilitated by focussed, openly available material, transparency of learning outcomes and association with courses), the directly visible benefit for the students (checklists, do's & don'ts, reference to same material in different courses, further reading), and the direct communication among the lecturers.

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LERNfeld

LERNfeld is an interdisciplinary science outreach course for young scientists (Master's students, doctoral students, postdocs) of the departments D-USYS and D-BIOL on the challenges of climate change and biodiversity for agriculture in collaboration with school classes. Participants get 1 ECTS and a LERNfeld certificate.

We established an interdisciplinary science outreach course for young scientists (Master's students, doctoral students, postdocs) of the departments D-USYS and D-BIOL on the challenges of climate change and biodiversity for agriculture. The course is part of LERNfeld, a science and education program for primary and secondary schools by GLOBE (https://www.globe-swiss.ch/de/Angebote/Landwirtschaft_LERNfeld). LERNfeld provides learning activities for schoolchildren, based on an inquiry-based learning approach about agricultural subjects in the context of climate change and biodiversity to promote systems thinking on challenges of food production.

The young scientists transfer their discipline-based knowledge to a non-academic audience and they cooperate with professionals from other fields (teachers and farmers). The participants act as tutors and teach good scientific practice in the field, e.g. on how to collect comparable data, how to analyze and interpret them and finally, how

to contextualize the results within biodiversity and climate change. Since the results of the inquiry-based learning approaches differ each time, the young scientists – together with the farmers, the teachers and the schoolchildren – act as partners in a learning community.

Participants train their communication skills and their performance as an expert. Both skills are important for scientists to interact with the public. The students improve their ability to work on their own (preparation of the topic and the experiments, communication with teachers, etc.). Additionally, they serve as role models to promote STEM fields to schoolchildren.

The students participate in a half-day introductory course. After an introduction into the LERNfeld project and before we clarify all organizational aspects, we execute one of the learning activities, during which the participants slip into the roles of farmers, teachers and schoolchildren to exercise different situations and reactions. At some points, we interrupt the activity with a movie clapper to switch to a meta-level for analyzing, discussing and coaching the situation from an outside perspective.

The participants then execute independently 2-3 learning activities with school classes and their teachers on farms. During their whole participation time, students fill out a time and task sheet to document their effort. Additionally, after the successful collaborations, the teachers sign the sheet. This serves as a performance assessment to get the credit point. During a one-hour feedback and reflection class, the participants meet again to exchange their experiences with their peers and with the lecturers

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MobileHCI4GIS: Competence development mobile user interfaces in GIS

This project has extended a Geomatics Master course by a part focusing on the development of Mixed Reality apps which visualize geographic data.

The project MobileHCI4GIS has extended the Geomatics Master course "Mobile GIS and Location-Based Services" with a part in which students acquire competences for the design and development of geodata-based applications for Mixed Reality glasses (Microsoft HoloLens). Mixed Reality user interfaces are particularly relevant for Geomatics because such interfaces enable the visualization and interaction with spatial information (e.g., maps or 3D city models), which is overlaid to real-world spaces.

A didactic concept was developed which – different to general programming courses – is particularly tailored to the pre-knowledge and interests of Geomatics students. In a combination of short lecture input, group work, and guided programming tutorials, students learned about the theoretical background of Mixed Reality, and gathered hands-on experience with preparing geographic data for Mixed Reality and integrating it into a HoloLens app. Particular emphasis was laid on the access to geographic data through web services, as well as on facilitating interaction with the data in HoloLens.

The students' performance was measured with a graded assignment, in which students each developed an own Mixed Reality app showing a 3D model of the ETH Hönggerberg campus. Furthermore, the students' task was to enhance the 3D model with geographic data from a web service, which had been collected in a location-based mobile phone game. The focus was on aspects such as the ability to live-query the online geographic

data, and the usability of the Mixed Reality app. Since students had developed the location-based mobile game for collecting the geographic data as part of an earlier assignment, the Mixed Reality part became well integrated with the overall content and schedule of the course.

In two project phases, which include two cycles of the course (spring 2019 and spring 2020), the didactic concept was developed, executed, evaluated and improved. Overall, the evaluation showed that students are excited about working with Mixed Reality and think that they have acquired important competences for the Geomatics job market of the future. However, the students' learning experience in spring 2020 was impaired by the unavoidable switch to online teaching during the COVID-2019 pandemics, which made it impossible to test the apps on physical devices. For the future, we envision switching to new devices (version 2 of HoloLens) and hope that we will again be able to offer physical access to devices to students.

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Monitoring the earth from satellites: Radar interferometry for geoscientists

A novel and unique course on space-borne SAR tailored to geosciences. Students develop independently projects on real case-studies by leveraging open source data and software. Students' performance is assessed by peers and by an international steering committee during a mini-conference.

Space-borne Earth Observation (EO) is deeply affecting many aspects of our everyday life. National and international space programs are continuously developed and the amount of information retrieved from satellite is exponentially growing. EO is becoming more and more important also for geoscientists, especially for the analysis of surface and subsurface processes at different spatial and temporal scales. Geoscience is traditionally rooted on direct observations, ground truth, and visual interpretations. Thus, teaching programs have been developed in the past to train students in that direction. In the framework of EO techniques, however, the use some data sources such require specific skills traditionally constrained to the remote sensing experts, such as strong engineering skills and IT backgrounds necessary to fully exploit the available information. This is the case for example for the analysis Synthetic Aperture Radar (SAR) imagery. On the other end, this technique is of great help for geoscientists to study the effects of earthquakes, to investigate volcanic unrest and eruptions, to observe displacements

due to landslides and land subsidence due to tunnelling or resource exploitation, and to monitor the stability of infrastructures. In the framework of the ETH Innovedum program, we developed a pilot course aimed at training the new generation of geoscientists to fully take advantage of SAR data for their future careers. The course objectives have been aligned to the learning goals of the MSc in Earth Sciences offered by ETH, by combining frontal lectures, workshops, games, and field excursions. All the practical part of the course is based on open source data and software, so that the students can also re-use the material in the future. The students' performance is finally assessed by the teacher, by peers, and by a committee of external experts during a mini-conference where the results of a group project (independently developed) has to be presented. This part is aimed at training important soft-skills, such as team work, as well as communication of results in a concise but precise fashion despite based on complex data analyses, and to deal with an audience with various backgrounds and needs. This new course offers to geoscientists the chance to learn a cutting-edge technique and to independently apply it to real scenarios. The course is very successful, and I received also requests to offer similar training to students from other universities, to engineering geology practitioners, as well as to employees of governmental agencies working in the field of natural hazards.

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NEWAL: A multi-disciplinary and cross-cultural learning experience for ETH students

The Network for Water and Life (NEWAL) learning experience brought together students from ETH Zurich, BFH, HSR, FHNW, as well as university students from Ivory Coast, Liberia, and Ghana to focus on the overarching topic of "Water and Life," equipping the students with knowledge and skills to help them conduct research with practical contributions towards more sustainable water use for humans and ecosystems.

The overarching and innovative goal of the Network for Water and Life (NEWAL) was to promote multi-disciplinary and cross-cultural learning with a focus on addressing sustainable development goals (SDGs). Especially in Africa, access to freshwater (SDG 6) is a prerequisite to achieving SDGs that pertain to health, food security, energy, and poverty reduction. Furthermore, overuse of water resources could lead to insecurity and potential conflict, while climate change will influence water availability in many regions. The critical importance of water for life therefore requires an approach that connects SDGs and develops a common understanding of how current and future water-related challenges can be met. The NEWAL learning experience was designed to include the following: 1) an introduction to global and local water problems at a winter

school in Africa; 2) independent MSc research activities including field work in Africa; 3) presentation of students' research and discussion of synergies at a summer school in Switzerland.

The winter school took place at the Kwame Nkrumah University of Science and Technology (KNUST) in Ghana in February 2020. In attendance were 8 students from Swiss institutions, including 3 ETH MSc students in Environmental Engineering, and 14 students from Ghana, Liberia, and Ivory Coast. The school included inputs by Swiss and Ghanaian faculty, field visits, meetings with stakeholders, and group work. It was a dynamic and inspiring week during which new perspectives were learned and new friendships were forged.

Unfortunately, due to COVID-19, the ETH students' planned field activities in Africa were cancelled but they adapted their research accordingly. At a virtual workshop in September, the 22 students from the winter school presented research results and discussed how their research can be used to address sustainable development challenges. New opportunities for collaboration among the involved institutions will be elaborated at future events.

The NEWAL format, which included a winter school in Ghana and interactions with African faculty and stakeholders, as well as field visits, was highly effective in sensitizing students to the true challenges of development facing local communities. Their research topics were subsequently chosen based on the issues that they observed to be most urgent. Field work would have further complemented this experience, but was unfortunately not feasible. Regardless, the relationships ETH students developed with their African counterparts and Ghanaian faculty have given them access to local knowledge that has helped them pursue research relevant to sustainable development targets.

Project funded by swissuniversities SUDAC programme

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Philosophy of Algorithms

The seminar “Philosophy of Algorithms” brings students from computer science, engineering and humanities into conversation about philosophical issues concerning algorithms. These heterogenous backgrounds enable highly realistic and controversial discussions about algorithms. The setting provides a unique space in which the students reflect their practices in academic, disciplinary and social contexts.

The seminar is geared towards bringing students from computer science and engineering and humanities into conversation about the philosophy of algorithms. These heterogenous backgrounds enable highly realistic, controversial and exciting discussions about algorithms. The seminar setting provides a unique space in which the computer science and engineering students can reflect their own studies, their work and the social contexts. In contrast to most other lectures in their main degree programs, this seminar specifically asks them to reflect practices, views, beliefs and decisions – in academic, disciplinary and social contexts.

All students read philosophical texts involving issues with algorithms in preparation for the class. In class they discuss the texts independently in small groups and in a teacher-led setting in the plenum. The teacher is both a moderator and a participant of the class discussions. These discussions are interdisciplinary and open: Every student has space to take up and articulate their own standpoint and perspective. At the same time, all students are reminded to listen to and include the perspectives of the other participants from other disciplines or with opposing views. Some of the questions that they consider are: Can we define algorithms in a way that is precise enough for computer science and understandable for people who merely employ algorithms? Which different agents can we distinguish for algorithms? Which ethical questions are pertinent when algorithms are used? Is there a difference between algorithms in high-stakes decision making and algorithms in low-stakes decision making? What explains biases in algorithms? How should we deal with biases in algorithms? Are computer scientists responsible for the algorithms that they program?

In order to gain the credit points the students can choose between submitting six short essays answering a question about the previous session, writing a longer essay about, or giving a class presentation on one of the articles read in the seminar. The teacher gives immediate, individual feedback for the six short essays and the students can thus improve their writing skills and ability to express arguments and objections. The teacher presents a selection of the students' insights from their essays at the beginning of the subsequent session so that the sessions are connected and the group learns about further observations concerning the previous topic and what are features of good and clear philosophical arguments.

By including computer scientific, philosophical and social perspectives the students learn to take up and defend their viewpoint and views confidently and reflectively. The basic set-up of the seminar can be adapted to other topics and other forms of outputs, e.g. preparing expert interviews, blog entries.

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PRISMA

PRISMA is a student-lead initiative that creates a community of interdisciplinary and open-minded students. It encourages the participants to analyze real-world challenges and learn from each other while working on potential solutions. Through PRISMA, students learn to put theories into context, think critically and widen their horizons.

What is the motivation behind the creation of PRISMA? On a Bachelor level, ETH students currently receive a strong foundation in specialist knowledge. However, they get fewer opportunities to put their learnings into context. PRISMA is based on the hypothesis that this should already be done on a BSc level and that students will recognize the value in doing so earlier on. We encourage students to confidently adapt to uncertainty and effectively cooperate with others to manage the ambiguous nature of real-world problems. To do so, three main approaches are used: a PRISMA course, sprinkling fundamental BSc lectures, and a series of networking events.

1. Course: The PRISMA Course is offered each semester across multiple departments, starting in the fall semester 2020. Each year it is themed on a different Sustainable Development Goal (SDG). This year, the focus is on the SDG11: "Sustainable Cities and Communities". Instead of giving the students a concrete task, they are asked to define

their own challenge and think of forward-looking solutions in teams. The methodology used is Design Thinking and our role-model, the ETH Week. MSc coaches accompany the BSc teams and are responsible for aligning the fast-paced process with team dynamics. This student-to-student coaching system fosters a more interactive constellation. The role of the coaches should be exclusively supportive and method-oriented to avoid biasing the group to think in a certain direction. MSc students can design their own teaching strategies in weekly workshops, running in parallel to the PRISMA course.

2. Sprinkles: While several independent attempts to enhance the representation of method-specific, personal, and social skills in fundamental BSc lectures already exist, PRISMA wants to address the problem in a more coordinated manner. We inspire and support BSc professors to introduce interdisciplinary and critical thinking elements – the so-called Sprinkles – into their lectures. Since they are embedded in already existing lectures, a large number of Bachelor students can profit from them without any additional time cost. This approach has a high scalability potential.

3. Networking events: Finally, PRISMA holds several networking events, not only to connect students from different disciplines among each other, but also to academia and industry experts. The goal of those events is to help the students widen their horizons and to build a bridge between university and society.

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Scientific Concepts and Methods

This one-week course introduces students to pivotal scientific methods of biomedicine by not only focusing on their application, but also the key concepts, assumptions and inferences they are based on. The aim is to train students in critical thinking and scientific reasoning – be it when scrutinizing their own experimental projects or when interpreting scientific texts from peer researchers.

Training in the life sciences usually focuses on teaching students how to apply scientific practices. While this is clearly important, it is insufficient if the goal is to educate students to become good, critical and responsible scientists. For this, students also need to learn and critically think about the concepts underlying their scientific research, hypotheses, methods, and inferences.

We have therefore designed a compulsory course that teaches Master students those concepts from the philosophy of science that are particularly relevant for the Pharmaceutical and Biomedical Sciences. The link to modern, hands-on biomedical research is provided in thematically matched talks of leading experts from different disciplines who present a pivotal scientific method; The students learn how the method works, what assumptions it is based on, which variables it assesses, and what data transformations

it employs. We have set-up the one-week course so that every day is dedicated to a key concept from the philosophy of science and a thematically aligned scientific method. The methods discussed include (i) animal models in preclinical drug development and their power and limitations in predicting therapeutic efficacy in humans, (ii) medical imaging techniques (fMRI), (iii) big data analysis in health science and care, (iv) analytical methods that shaped the paradigms of inflammatory bowel disease, (v) practical applications of scientific results and the economization of science. The corresponding philosophical inputs are on (i) scientific reasoning and experimentation, (ii) the role of images in science, (iii) mathematization and digitization of science, (iv) continuous versus revolutionary developments in science, (v) applied versus basic research. Each day, the philosophical and scientific topics are brought together in an interdisciplinary discussion between students, philosopher, and expert.

Critical thinking is most challenging when it is applied to one's own research; The experimental setups, assumptions and results need to be scrutinized, alternative approaches and interpretations need to be evaluated. We ask our students to reflect on their own scientific project work using the concepts introduced in the course. They write their thoughts onto the online whiteboard KNOW (Knowledge Network Online Whiteboard; http://www.ethz.ch/know) and discuss them with their peers. Having students reflect on their own experiments is an excellent method to get them deeply and also emotionally involved into critical reflections and scientific debates.

In the three years that we have taught the course by now, we were excited to see how actively the students shared, explained and discussed their thoughts on their own work.

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Student Project House

ETH Student Project House is open to all students, who wish to learn how to identify a need, design a solution and test a hypothesis with prototypes. Students receive project support from experienced mentors, have access to training, a co-working space and a Makerspace equipped with machines to build prototypes.

ETH Student Project House is an initiative of rector Prof. Dr. Sarah Springman, in operation since 2016. The Student Project House is open to all students, who wish to learn how to identify a need, design a solution and test a hypothesis with prototypes. Students are encouraged to realise their ideas and projects, in their own time and regardless of their courses of study or credit requirements. They receive project support from experienced mentors, have access to training, a co-working space and a Makerspace equipped with 3D printers, laser cutters as well as many other tools to build prototypes. Furthermore, they receive initial funding to test their idea.

The Student Project House complements the curriculum of ETH. Combining the knowledge gained in studies with the freedom of tinkering can lead to great innovations and most importantly, it prepares our graduates for the future. Such engagement enables them to gain valuable experience and skills, for example, in project management and

teamwork. Above all, our students develop the following maker and innovator mindset, which they can apply to any situation and environment they will encounter in the future:

- You Can Do It (finding the courage and confidence to start a project that matters to them)
- Better Together (interacting with others and welcoming feedback)
- Enjoy Creating (exploring new tools, building prototypes early, and having fun experimenting)
- Fail Forward (seeing failure as an opportunity to grow)
- Test & Adapt (challenging assumptions and adjusting the approach accordingly)
- Seek Diverse Views (being curious about people, project and ideas, which challenge one's own perspective)

Since the opening, more than 1.500 students from 16 different disciplines and 100 projects have been supported by the Student Project House. Due to the extracurricular nature of our offer, the learnings are currently captured in a qualitative way through surveys. A more structured approach may be developed in the future to better capture the mindset delta. Additionally, we are in the process of restructuring our offer to allow a more scalable approach, so that in the future even more students can benefit from it.

At the fair, we would like to inspire and encourage participants to actively experience the learnings, which students gain at the Student Project House. Within just a few minutes, participants are inspired to generate ideas to a challenge, develop a paper prototype and test their idea. Thus taking home glimpses of the maker and innovator mindset.

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ETH Student Project House,
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Thriving in the grey zone – ETH's educational ethics game

As part of the ETH's Future Learning Initiative we are developing an educational ethics game. The project is a collaboration between the Chair for Learning Sciences and Higher Education, the Game Technology Center, the Chair for Bioethics, and the LET.

Our game is a preparatory activity for a new 1 credit point course for all doctoral students across disciplines at ETH, consisting of digital and face-to-face components. It will be implemented and evaluated in 2021. The game leverages the inherent ambiguity of ethical decision-making and seeks to make them experience-able. It 'forces' students to weigh in on complex ethical grey-areas that they otherwise merely talk about.

Meaningful ethics education is more important than ever. The rapid advance of technology and science is increasing the gap between what we can do, and our understanding of the ethical ramifications of our actions. As a world-leading science and technology university, ETH has a recognised its responsibility to train its doctoral students in ethics. Research ethics in particular build the foundation for ethical scientific and technological progress. Our Ethics Education project and the educational ethics game we are developing as a key part of it are part of ETH's strategy to honour that responsibility. Ethics is mostly taught in traditional educational arrangements such as lectures or seminars. While students generally enjoy discussing ethical dilemmas in groups, we argue that these arrangements are inadequate for a complex domain such as Ethics. Ethics is a challenging

domain, in part, due to the its inconclusive nature. Ethics, rather than a static set of principles, has to be understood as a contextualised and dialogic practice. Furthermore, ethical deliberation and conduct combines fixed, law-like rules with personal motivations, responsibility as well as awareness of individual and cultural values.

In a game, students are 'forced' to weigh in on ethically challenging situations. The game allows them to explore their own preconceptions and provides a risk-free environment for ethical experimentation - even with 'unethical behaviors'. Our game is different from other educational games in that it purposefully creates moments of ambiguity. The ethics of academic collaboration and publishing which this game addresses, is challenging due to inherent ambiguity. A game that makes this goal-/rule-ambiguity experience-able, and incorporates the covertness of consequences-to-action is, from that perspective, valuable. An ethics game, like any game, provides a virtual environment that gives meaning to behaviour. In what we consider a transformational ethical game experience, the meaning of the consequences develops over time. It is the result of the player's efforts to make sense of her behavior in the game ontology, rather than being constituted by reliable system-feedback.

We are currently working on the first implementation of the game, which we will test with 10-15 students in August 2020. If succesful, the game could be implemented throughout postgraduate degrees at ETH. At the Learning and Teaching fair we would invite the public to play the game and engage in discussion about the 'grey-zones' of the ethics of research. We will also be able to present initial findings from our first round of data collection later this summer.

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Visual, interactive learning applications for self-motivated studying in structural concrete

New visual, interactive material for the courses "Structural Concrete I/II" is developed. These shall challenge the curiosity and critical thinking of the students by applying and strengthening their theoretical knowledge in interactive examples in a self-motivated manner. In addition, by establishing a stronger link between theory and real-life applications, the motivation shall be increased.

The project developed new interactive, animated course material for the "Structural Concrete I/II" courses of the D-BAUG Civil Engineering Bachelor programme. These courses are mostly taught with a conventional approach of frontal lecturing for the entire class and a limited number of guided exercises and colloquia organised in smaller groups, complemented by a couple of site visits during each year. Although the lectures have always been evaluated with high marks by the students, the course material kept being rated slightly lower than the rest of the course. The current curriculum focuses on a mechanically consistent treatment of structural concrete based on a rigorous application of equilibrium and the theory of plasticity. This serves as a solid basis for structural analysis and design, applicable to any building material and fostering the student's ability to develop appropriate models for non-standard cases. However, the current teaching approach is limited when it comes to enhancing the student's self-driven learning

motivation. Therefore, the students' curiosity and critical thinking shall be fostered by additional course material allowing an interactive, exciting approach to the theoretical concepts – attractive in particular for today's generation of "digital native" students. To this end, we have developed virtual experiments, animations and selected physical models presented during the lectures (as a surrogate for large-scale experiments as used in research, which would be unmanageable in teaching). Virtual experiments and analysis tools allow the students to conduct their own parameter studies for given problems and test setups. This will engage them more in understanding physical relationships and the basics of mechanical modelling. Since the experiment is controlled by student (e.g. increasing the load with a slider), intermediate steps can be reported and especially, transition phases can be examined with special attention.

In the first phase, we have implemented the use of the applications and physical models mostly within the lecture to either introduce a new topic or enhance the knowledge about a problem that was introduced earlier with conventional teaching approaches (blackboard or slides). The applications help understanding dynamic and continuously changing phenomena where static representations soon reach their limits. In this year's student evaluation, the use of the new material in the lecture was highly appreciated.
In the second phase starting from now, we will further revise the course material with a special focus on the exercises, where the advantages of a combined use of hand calculations and virtual experiments shall be enhanced and the students shall be motivated to use the applications more by themselves.

According to the student evaluation, the applications are also beneficial for exam preparation. The teaching approach can be applied in many other disciplines, where virtual experiments can be a supplement or replacement for real tests in the laboratory. The applications are available over an online platform and therefore, a large number of students can participate.

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Table of Names

CHANGING STUDENTS' PERSPECTIVES

LEARNING WITH DIGITAL TOOLS

FOSTERING NON-DISCIPLINARY COMPETENCES

TEACHING IN AN INTERDISCIPLINARY SETTING

EXPLORING NEW WAYS TO TEACHING AND LEARNING

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