JACOBS UNIVERSITY

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BOOK OF ABSTRACTS

BILDUNG BEYOND BOUNDARIES (B^3)

FINAL SYMPOSIUM
JUNE 14, 2022

In collaboration with researchers from:

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

RWTH AACHEN UNIVERSITY

Technische Universität Braunschweig

UiA University of Agder

jacobs-university.de/b3

Final Symposium
"Bildung Beyond Boundaries" (B^3) Framework
Bremen, June 14, 2022

Welcome

On a good summer day in June 14, 2022, academics, researchers and partners who have collaborated tirelessly for the successful completion of their "Bildung Beyond Boundaries – B^3" Projects, finally came together, in person, after two years of social distancing and remote work. The occasion was the Final B^3 Symposium, in which researchers of nine interdisciplinary projects presented their evidence-based results among members of our academic community at Jacobs University.

During the symposium, the opportunity to hear from each other in-person; to ask challenging questions and to continue to promote academic transformation as a trans-disciplinary community of practice, allowed us to reinvigorate our belief that pedagogic innovation should be open in subject, methodology, and discipline.

It also became evident during this special occasion, that the strength of the B^3 Model does not lie on singular project results; but rather, on the paradigm shift that the Framework itself represents. Its focus on evidence-by-design structure clearly differentiates B^3 from other German grant opportunities that tend to favor anecdotal evidence rather than scientific rigor. With the successful, and final, B3 Symposium on June 14th, the B3 Framework has reached its preliminary peak, but calls for translational research in academic education.

On the coming pages, readers will find the abstracts of the research projects presented during the "Final B^3 Symposium", as well as, some images of that special day. Our hope is that scientists, educators and the general public interested in the field of pedagogic innovations in higher education, find the ideas presented here inspirational and useful. Enjoy the reading!

Dr. Jessica Price
B^3 Project Coordinator, Jacobs University.
Bremen, July 2022

About "Bildung Beyond Boundaries" (B^3)

The “Bildung Beyond Boundaries”- B^3 Framework is committed to the development of groundbreaking and radical ideas for innovation in higher education. This initiative is a collaboration between the Jacobs Foundation and Jacobs University that sponsored two rounds of research projects, which have generated important outcomes pertaining to evidence-based teaching methods and student centred pedagogies. As evidence of its commitment, the Jacobs Foundation generously contributed 1,5 Mio CHF for this purpose, and in 2019, nine research project proposals were selected out of a pull of 37 that were submitted during the first and second application rounds.

In spite of the challenges imposed by the COVID-19 pandemic, all projects developed experimental advancements during the following two years. Researchers from Jacobs University partnered with academics from 14 other academic and cultural institutions, generating rich exchanges and testing their ideas at German classrooms and abroad. At Jacobs University, our academic community joined more than ten B^3 academic events aimed at generating awareness of new pedagogical methods involving the creative use of digital tools during the crucial post-pandemic semesters.

The contributions of the B^3 researchers could not be more relevant at this point in time, when higher education faces a unique crossroads characterized by the lingering effects of a pandemic that has catapulted digitalization, coinciding with advances in artificial intelligence and the use of algorithms and digital personalization in education. These developments, paired with the unique needs of our “digital native” students, are no longer served by educational approaches that rely on the conventional classroom model.

The B^3 research projects introduce tools such as: the algorithmic partnering of students in group work; individualized hands-on education 4.0 including gamification; 3-D platforms that enable needs-based student support; the virtual access of historical sites and narratives through a hybrid museum and the development of a laboratory experience from student´s homes, among other intriguing ideas.

For more information on our projects, we invite interested audience to review the “Bildung Beyond Boundaries – B^3” website: https://www.jacobs-university.de/b3

Final Symposium
“Bildung Beyond Boundaries” (B^3) Framework
List of Abstracts

Hands-On 4.0 Individualized Applied Education in the Digitalization Age

Project Chairs: Prof. Dr. Andreas Birk and Prof. Dr. Francesco Maurelli.
Team Member: Dr. Evelina Dineva

The importance of hands-on elements in education has been acknowledged since ancient times when contemplation about education started. As Aristotle already stated in 350 BC:

"For the things we have to learn before we can do them, we learn by doing them."

Hands-on elements have accordingly been an important element in education throughout different times and cultures, though without much conceptual reflection in the early days. This so-to-say handson education 1.0 was typically based on a master-apprentice relation, where the apprentice is guided by the master on a learning path from executing simple tasks up to the full knowledge of the subject matter, i.e., until mastership of her/his own.

Things got a bit more systematic and formalized with the rise of university laboratories as elements of academic studies. This hands-on education 2.0 is rooted in the use of laboratories for research, for which best practices and procedures are taught in lab courses. This includes especially the formalized concept of an experiment and the related best practices and procedures structured into hypothesis formulation, trials under controlled conditions, analysis of the outcomes, and formalized documentation.

The hands-on education 3.0 can be linked to experiential learning. It not only encourages the learning by doing, but it also includes strong elements of reflection on doing by the learner. Experiential learning is rooted in psychological research including the work of Jean Piaget, John Dewey, and Kurt Lewin. An important element is the insight that education is most effective if the learner has an actual desire to adsorb the knowledge. Hence, experiential learning approaches often include playful elements.

In the spirit of Industry 4.0, the project dealt with first steps toward a hands-on education 4.0, i.e., striving for:

Hands-On 4.0 Individualized Applied Education in the Digitalization Age

- An individualized education that takes the interests, the existing knowledge, and the personality of the learner into account;
- it features flexibility in achieving the Intended Learning Outcomes (ILO) by assigning the learner a role in a team, which can be dynamic in its scope as well as dynamic within and across teams.
- The achievement of ILOs includes decentralized decisionsin teams of learners with input from teachers and experts to define and assign roles.
- The methods and tools include a high amount of interoperability, i.e., the lab components are based on standardized, open-source material developed in international communities.

In addition to sharing commonalities in concepts with industry 4.0, the term hands-on education 4.0 is also deliberately chosen to trigger associations with core technologies of the digitalization age including Cyber-Physical-Systems (CPS), Internet of Things (IoT) and Cognitive Computing, which are associated with industry 4.0 and which will be the prime topics for the start of hands-on 4.0 at Jacobs University.

During the project, the CoViD-19 pandemic lead to an unprecedent challenge to education around the globe. Especially, it led to a fast and often ad-hoc switch to online education. While this posed a lot of challenges to institutions, instructors, and students, it also provided opportunities for the hands-on 4.0 project. Especially, it allowed to investigate the relation between modern online education and hands-on elements typically associated with in-presence, brick-and-mortar labs.

In addition to activities linked to in-presence education like excursions, a summer school, or the investigation of group formation in cooperation with B3 AMIGO project for labs in the "Robotics and Intelligent Systems (RIS)" BSc program, there was accordingly an extensive investigation of online aspects related to hands-on education. These include online classes with flipped classroom elements as well as the use of online concepts in RIS labs including the investigation of the use of take-home hardware, simulation, and remote access.

Furthermore, an international survey among robotics instructors was conducted that sampled the effects of the CoViD-19 pandemic on lab education.

Hands-On 4.0 Individualized Applied Education in the Digitalization Age

The outcomes of the survey include the following:

- There was an overwhelming switch away from in-presence at brick-and-mortar locations to online labs during the pandemic
- Instructors strongly belief that the students' education substantially suffered
- But there is no evidence that the students' performance was indeed worse
- There is a strong agreement among instructors that many of the changes toward online elements in labs and other hands-on education will also be used in the future.

Concluding, while there is a strong belief that labs must be in-presence, the use of online elements may also be an interesting option for hands-on education – though it is clearly a development that is still in its infancy and which still requires some more research and development to leverage its full potential.

References

[1] Andreas Birk and Dora Simunovic. Robotics Labs and Other Hands-On Teaching During COVID-19: Change Is Here to Stay? IEEE Robotics and Automation Magazine (RAM), 28 (4), pp. 92-102, DOI: 10.1109/MRA.2021.3102979, 2021

[2] Francesco Maurelli, Evelina Dineva, Andreas Nabor, and Andreas Birk. Robotics and Intelligent Systems: a new curriculum development and adaptations needed in Coronavirus times. Robotics in Education (RiE), Advances in Intelligent Systems and Computing, vol 1359, Springer,2021

[3] Andreas Birk, Evelina Dineva, Francesco Maurelli and Andreas Nabor. A Robotics Course during CoViD-19: Lessons Learned and Best Practices for Online Teaching beyond the Pandemic. Robotics, 10(1), https://doi.org/10.3390/robotics10010005, MDPI, 2021

[4] Andreas Birk and Evelina Dineva. Improved Students' Performance in an Online Robotics Class during COVID19: Do Only Strong Students Profit? Robotics in Education (RiE), Advances in Intelligent Systems and Computing, vol 1359, Springer, 2021

Hands-On 4.0 Individualized Applied Education in the Digitalization Age

Professor Andreas Birk presenting his project results at the “Final B3 Symposium”

The DeALS-Phys Project: Towards an Individualization of Weekly Homework

Project Chairs: Prof. Dr. Jürgen Fritz, Prof. Dr. Veit Wagner, and Prof. Dr. Christian Stamov-Roßnagel (Jacobs University Bremen). Team Members: Dr. Julie Direnga and Dr. Milos Kupresak.

One can observe a common problem when students with different backgrounds (e.g. due to different educational systems) sit in the same first year course at university: one part of students is overwhelmed by the new information whereas another part is bored since topics have already been covered in school. The question arises how one could keep all students equally interested and motivated and support them due to their individual needs?

The DeALS-Phys project (**D**evelopmental **A**daptive **L**earning **S**upport for **Phys**ics Students) addresses this problem especially for weekly homework in physics, which is an integral part of any physics education worldwide. We show the importance of homework and its predictive power for the final grade, factors which can influence homework success of students, and possible ways to adapt homework to student performance.

We present and discuss our pragmatic approach for offering different homework to different groups of students in a first year physics course. Further ideas on improving the homework experience for physics students will be discussed.

Professor Jürgen Fritz presenting project results during the "Final B3 Symposium"

"AMIGO" – Algorithmic Method for Improved Group Formation Online

Project Chair: Dr. Henrik Bellhäuser from Johannes Gutenberg-Universität Mainz.
Collaborators: René Röpke, M.Sc. from RWTH Aachen University; Prof. Dr. Johannes Konert, from Hochschule Fulda - University of Applied Sciences;
Prof. Dr. Peter Baumann; Prof. Dr. Sonia Lippke and Dr. Stanislav Chankov (Jacobs University Bremen)

Learning in study groups is an effective learning strategy and is widely used in university learning. However, little attention is paid to the composition of learning groups, although this contributes to the success of learning groups. Empirical findings come almost exclusively from correlative studies, since an experimental manipulation of homogeneity or heterogeneity of learning groups is hardly feasible without algorithmic support. In the context of an interdisciplinary project between psychology and computer science, we employ a software (MoodlePeers; https://github.com/moodlepeers), which allows group formation based on predefined criteria. After the selected criteria have been diagnosed in a questionnaire for each person, the algorithm forms groups that are either homogeneous or heterogeneous with respect to the chosen criterion.

Collaborative learning has been proven to be a very effective method in a variety of empirical studies (Kyndt et al., 2013). The advantages over individual learning include not only subjective aspects such as satisfaction but also objective achievements. Less intensively researched is the question of the criteria according to which the study group members should be selected for collaborative learning. Correlative studies have shown that demographic characteristics such as gender, age, or educational attainment have a relatively weak correlation with the success of groups (Harrison, Price, Gavin, & Florey, 2002). In contrast, stronger relations were uncovered between psychological attributes such as personality traits, attitude, and group performance.

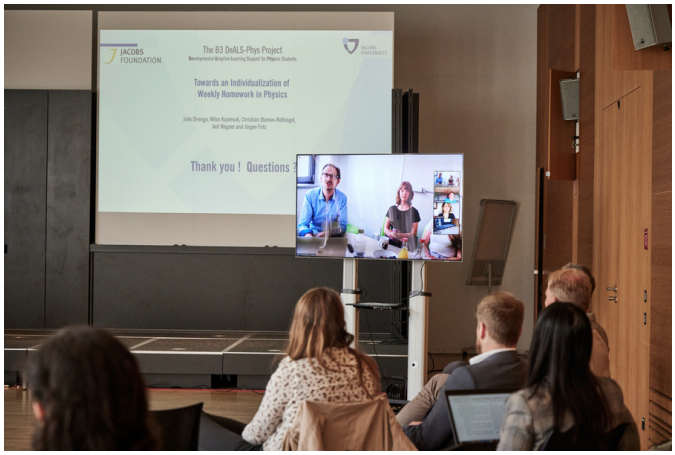
Out of the five dimensions of the widely established Big Five personality traits (Rammstedt & John, 2005), it is primarily extraversion and conscientiousness that are considered relevant to the group formation (Humphrey, Hollenbeck, Meyer, & Ilgen, 2007). For extraversion - a trait implying not only sociability but also leadership behavior as one of its facets - a heterogeneous

"AMIGO" – Algorithmic Method for Improved Group Formation Online

group composition is deemed to be conducive so as to avoid conflicts between numerous individuals with leadership claim. For conscientiousness, a homogeneous group composition could be regarded as beneficial, as larger differences between group members would be detrimental to the formulation of common group goals. Members with greater conscientiousness would probably have higher expectations regarding group performance compared to members of lower conscientiousness.

Beyond the Big Five personality dimensions, various other psychological traits were observed to be relevant to group formation. Bell (2007) identifies team orientation (the preference to work in group settings for task accomplishment) as a criterion that should be distributed homogeneously, so that group members may agree more readily on the degree of collaboration. Further factors that could serve as potential grouping criteria for future studies are motivation and goal orientation (Nederveen Pieterse, van Knippenberg, & van Ginkel, 2011), leadership (Lykourentzou, 2016), as well as general cognitive abilities and prior knowledge (Horwitz, 2005).

In this talk, we will provide an overview of the work that we conducted in the AMIGO (Algorithmic Method for Improved Group Formation Online) project at Jacobs University between 2019 and 2022. Several empirical studies investigated a wide range of research questions such as whether students accept being grouped by an algorithm, which students choose an algorithm over picking their own group members, and what are the learning outcomes for groups that are formed by algorithm. We will also present an outlook on future work that we intend to carry out.



Dr. Henrik Bellhäuser and his team at Johannes Gutenberg-Universität Mainz presenting online during the “Final B3 Symposium”

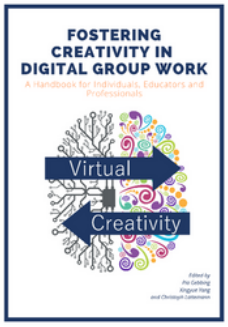
Imparting Creativity in Distance Learning

Project Chair: Prof. Dr. Christoph Lattemann
Collaborators: Prof. Dr. Bjørn-Tore Flåten; Dr. Øystein Tønnessen and Dr. Päivikki Lahtinen (University of Agder, Norway); Dr. Felix Becker from Technische Universität Braunschweig
Team Members: Xingyue Yang, Pia Gebbing and Raoul Pilcicki (Jacobs University Bremen)

About the project

Digital transformation is changing the way we collaborate - be it in education or in business. To master digital group work, we need to develop new, innovative approaches and original ideas. Creativity is therefore essential and seen as one of the most important core competencies of the 21st century.

In a cross-border project “virtual creativity”embedded in B3 (Bildung Beyond Boundaries) project, the Technical University of Braunschweig (TUB), the University of Agder (UiA) and Jacobs University Bremen (JUB) investigated how didactic concepts, methods and information and communication technology (ICT) can be designed to promote the soft skill "creativity" in digital environments. Since January 2021, the research question was explored from different perspectives and interdisciplinary approaches, including bibliometric literature reviews, exploratory survey, and qualitative interview studies. Online Design Thinking courses provided a specific context of application to test and develop the insights. It is a collaborative innovation approach that has proven to be a valuable concept for fostering creativity in a face-to-face context, yet under researched in the digital format. The solutions developed findings have been published in a handbook entitled "Fostering Creativity in digital Group Work". Our research enables teachers and practitioners alike to incorporate more creativity into their (online) group work.



Handbook “Fostering Creativity in digital Group Work”

This handbook demonstrates how creativity can be strategically fostered and encouraged in digital environments. Practitioners, educators, and every day people will find tips and advice from interdisciplinary research on creativity in the virtual setting. The handbook can be downloaded and accessed free of charge: please click here.

Imparting Creativity in Distance Learning

The following topics are covered in the handbook:

- Curricula - How to Enhancing Creativity in Education?
- Creation & Consumption - What is a Creative Idea? How to Measure Creativity?
- Creator - Are you born creative? Or is it a skill you can develop?
- Collaboration – Why less is more in the digital environment?
- The Process of Creation - How to Approach a Creative Task?
- Context - Suggestions for instructors and individuals
- Context - Suggestions for managers and employees

Publications within the context of the project B3 – Imparting Creativity in Distance Learning

Throughout the project, the following publications were published and presented at various conferences:

Borjas, A. M., & Gebbing, P. (2021). Teaching and Learning Creativity in Virtual Settings. GeNeMe'21 Gemeinschaften in Neuen Medien, 151–158. https://doi.org/10.25368/2022.37

Gebbing, P. (2022). Creative Virtual Collaboration Through the Lens of Design Science Research. Creativity and Cognition (C&C '22), 6. https://doi.org/10. 1145/3527927.353373

Gebbing, P., Lattemann, C., & Siemon, D. (2022). Creativity Drivers: Design Principles for Virtual Creative Collaboration. PACIS Conference Proceedings.

Gebbing, P., Yang, X., Michalke, S., & Lattemann, C. (2021). Kreativitätsförderung in der virtuellen Gruppenarbeit. HMD Praxis Der Wirtschaftsinformatik, 1–14.

Gebbing, P., Yang, X., Lattemann, C., Becker, F., Flåten, B.-T., Lahtinen, P., Tønnessen, Ø., & Pilcicki, R. (2022). Fostering Creativity in Digital Group Work—A Handbook for Individuals, Educators, and Professionals.

Pilcicki, R., Siemon, D., & Lattemann, C. (2021). How Virtual Teams Collaborate Creatively under Communication Constraints. AMCIS 2021 Proceedings.

Pilcicki, R., Siemon, D., & Lattemann, C. (2022). How Feature- and Communication Constraints in CSS Affect Creative Collaboration in Virtual Teams—An Activity Theory Perspective. Hawaii International Conference on System Sciences. https://doi.org/10.24251/HICSS.2022.056

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Siemon, D., Strohmann, T., & Michalke, S. (2022). Creative Potential Through Artificial Intelligence: Recommendations for Improving Corporate and Entrepreneurial Innovation Activities. Association for Information Systems

Tønnessen, Ø. (2022). Employee Creativity in Coworking Spaces: Towards a Conceptual Framework. European Journal of Workplace Innovation, 7(1), 53–83. https://doi.org/10.46364/ejwi.v7i1.891

Tønnessen, Ø., Dhir, A., & Flåten, B.-T. (2021). Digital knowledge sharing and creative performance: Work from home during the COVID-19 pandemic. Technological Forecasting and Social Change, 170, 120866. https://doi.org/10.1016/j.techfore.2021.120866

Yang, X., Gebbing, P., Lattemann, C., & Michalke, S. (2021). Critical Factors for Improving Creativity in Virtual Teams. ISPIM Conference Proceedings, 1–10.

Pending publications:
Yang, X., Gebbing, P., Lankut, E., & Lattemann, C. (2022). Virtual Creativity—Bibliometric Literature Review on Measurements and Factors That Influence Creative Virtual Teamwork [Manuscript submitted for publication].

From left to right: Xingyue Yang, Felix Becker, Øystein Tønnessen, Christoph Lattemann, Pablo Zerm, (from the Jacobs University Management Board) Pia Gebbing and Bjørn-Tore Flåten

Professor Christoph Lattemann presenting his project results at the “Final B3 Symposium

Digital Contingencies: Prospects and Limitations of Technology in Digital Humanities

Project Chairs: Dr. Julia Timpe and Prof. Dr. Andreas Birk
Project Coordinator: Ms. Frederike Buda

The project ‘Digital Contingencies: Prospects and Limitations of Technology in Digital Humanities’ has been focused on an exploration on how to scientifically deal with inaccuracies in data. For this, a third-year module at Jacobs University was developed, integrating data from the BMBF research project, ‘Valentin3D’ and making it available to students enrolled in the module. A mixture of project-based and problem-based learning approaches was employed on the module - which was called ‘Spatial Technologies in Digital Humanities’ and which was offered in Spring 2021 -, prompting participating students (from study programs CS, RIS and IRPH) to tackle inaccuracies from different angles. In this talk, we will detail our educational approaches and content, and discuss some challenges the project faced as well as our overall findings.

Project Coordinator, Ms. Frederike Buda presenting project results of the Project “Digital Contingencies” at the B3 Symposium.

"Hybrid Neighborhood Museum - Portal to the World"

Project Chair: Dr. Jakob Fruchtmann
Collaborators: Dr. Rüdiger Ritter (historian); Ms. Alena Klein; Prof. Ulrich Kühnen and Prof. Vikram Unnithan (Jacobs University)
Project Evaluation: Dr. Alyona Khaptsova

The evaluation research accompanied the development of the Portal to the World for two semesters (Spring 2021, Fall 2021). The aim of the evaluation of the Portal to the World was threefold. First, the evaluation concerned the achievement of the intended learning outcomes (ILOs) of the course by students. Second, the investigation of the strengths and weaknesses through the collection of the students' impressions about the format of the course was the focus of the research. Third, the evaluation collected and analyzed students' proposals for future revisions of the course.

29 students (~30% of all students enrolled in the Portal to the World) participated in individual or group confidential semi-structured interviews. All students had an opportunity to decline the invitation to participate in the evaluation without experiencing any negative consequences for themselves, each student was informed about their right to quit the interview at any moment or withdraw their data at any moment after the interview. Interviews lasted between 30 and 60 minutes. All collected data was analyzed by means of content or thematic analysis.

The project was guided by the four ILOs: ability to apply theoretical knowledge to the solution of real-life problems (Academic achievement), development of professional confidence and skills (Professional competence), experience and better understanding of the civic engagement (Civic engagement), and greater ability to integrate in the Bremen community (Integration). The achievement of the ILOs by students depended on the fit between their majors, specific tasks in the project and personal interests. All students reported they achieved at least one of the four outcomes, however, no student reported the achievement of all four outcomes.

The self-evaluation of the academic achievement depended on students' expectations and subjective perception of the fit between their major and project tasks. The development of the professional competence was dominated by the gain of transferrable skills like teamwork communication with peers, time management. No student reported they became more confident as future professionals.

“Hybrid Neighborhood Museum - Portal to the World”

Students had rather diverse self-evaluations of their experiences with civic engagements as they relied on very divers definitions of what it means and how it should be evaluated. Some students reported this outcome as underachieved due to the lack of personal interest in civic engagement or (mis)interpretation of the current social issues. Finally, the integration in Bremen was a desired outcome for many students which tended to remain underachieved. The main reasons were Covid-restrictions which limited the contact between people, project tasks which did not require communicating with anybody outside the campus and the language barrier.

The students’ feedback regarding the format of the course tackled four major topics. The first was the attitude towards the diversification of regular classes with a pure hands-on course. While some students expressed their enthusiasm about the format, others found it stressful. Second topic pertained to the subjective evaluation of the value of the new experience for the future professional life. Some students noted, the course is worth mentioning in the CV as it gives them a competitive advantage over other graduates. Thirdly, the value of the initiatives that enable integration of the Jacobs University community into the local community was emphasized. Finally, some students noted that participation in the project provides learning opportunities beyond the ILOs: for instance, the observation of the project planning and development, working groups coordination, etc.

Dr. Jakob Fruchtmann presenting highlights of the Project “Hybrid Neighborhood Museum”

Dr. Alyona Khaptsova presenting the project evaluation during the B3 Symposium.

"Redesigning a Biochemistry Laboratory Course"

Project Chair: Professor Dr. Sebastian Springer

What do we teach at Jacobs university, and what can be taught at all to undergraduate students that is useful to them? The answer to these questions appears simple, but in reality, the closer one looks, the more difficult it gets. I would like to show this here using the example of the advanced Biochemistry laboratory course. The outset is obvious: in the experimental natural sciences, laboratory courses are essential for delivering excellence in undergraduate education. In addition to factual knowledge about methods and techniques, they train practical and organizational skills, mental presence, focus, and attention to detail. Successful completion of an experiment, especially a difficult one with undefined outcome, gives to students a boost in confidence in their own abilities that is difficult to match in any other teching setting. Laboratory courses are also essential in order to prepare students for their internships, their BSc thesis, and graduate school. One very important aspect is the possibility of failure: since natural science experimentation requires precision, mental presence, and thought, those students who are not ready to apply these will not reach a successful outcome, and will thus not manage to complete the experiments successfully. One example for this is an old-style inorganic chemistry laboratory course that I took in 1986: from a given mixture of salts, the task was to define, by chemical experimentation, all the ions that were present in it. Such experiments usually take time, maybe several days; they are highly individual, because of the differences in the experimental approaches that depend on the nature of the sample; they will fail several times before the complications are overcome; and they give the student a supreme feeling of achievement and competence because the successful outcome only depended on their own intelligence and dexterity.

But at Jacobs (as at other universities), laboratory courses are subject to many restrictions: institutional ones, through capacities, finances, and curricula; and (since they are in the center of the action) also students' abilities, insecurities, and work overload. Most importantly perhaps, as a result of the Bologna reform, lab courses are limited in time (typically taking just four hours for an experimental day), and the option of failing students is undesirable at Jacobs since it will lead to overload (students taking the course several times), severe financial penalties (if students need an additional semester), and a loss of focus on the third-year BSc thesis (if students repeat the course in their third year). Because of this, the experiments in the natural science lab courses have been

"Redesigning a Biochemistry Laboratory Course"

‘sanitized’ such that they cannot fail, and they have been taught in a student-passive mode, much like a cook-book, that limits the students' ability to explore but also the chances of failure and thus their level of accomplishment in succeeding. Such courses instead support short-term cramming of contents, mental absence in the lab, and copying of result evaluations from students in previous years.

The purpose of the B3 project “Redesigning a laboratory course“ was to explore which measures can be successful in returning some autonomy to students and reintroducing thinking into the laboratory. We initially thought that students might be able to come up with their own experiments, designed with the help of extensive guidance on methods provided on Teamwork, but we found that it would take a group of students one semester to complete a functional lab manual, even with extensive supervision. We then decided to use the means of the B3 grant to do a lab manual exercise anyways, with a view on perhaps using the manual for experiments in the next semester. One thing that worked well about this, in an unexpected fashion, was that students made contact with PhD students and postdocs of research laboratories, asking them about methods and techniques. Critique of students included that the new lab course, with the lab manual writing exercise, took away too much time in an already very crowded fourth semester.

We then realized that if it was not possible to have students create and generate their own experiments, at least they should be very well informed about the course days before attending. This was in the past achieved through quizzes, for which students would have to study the lab manuals. Following the idea that creating is more advanced than reproducing, we asked students to write an introduction to each experiment they were about to do and then submit it, on the day before the experiment, on Turnitin. Students resisted this, having been used to coming to the laboratory with very little preparation, and thinking about the experiment only in the post-experiment evaluation. We decided to help them by introducing seminars to be held before each laboratory experiment, where students could ask questions, but we realized that they came totally unprepared, and the meetings were useless. Thus, we resorted to recording extensive videos as introduction to the laboratory experiments, about an hour for per experiment, and additionally short five-minute videos on the methodology. Videos have the advantage over introductory seminars that students can watch the videos whenever they need to, typically at 3:00 am, when they are preparing the laboratory experiment introductions that are meant to be submitted the next day. Such 'on demand' content also stimulates peer teaching to an extent since students will exchange information among each other about it when they are doing the writing. The method turned out to be very successful altogether, with students in the lab well-informed about what they were going to do, and the lab

"Redesigning a Biochemistry Laboratory Course"

days coming out to be substantially shorter than in the previous years due to the better familiarity of the students with the aims and techniques.

We then focused on the bottlenecks of understanding in the laboratory course and found, a bit surprisingly perhaps, that students' knowledge of practical mathematics, as used in for example setting up a dilution, was very limited. We tried several ways to deal with this but then generated a thorough manual called 'Biochemical Calculations', and then introduced an additional course day to first teach and then test calculation skills, mostly through peer instruction. This increased to a certain extent the practical calculation abilities of the students, albeit more specific training would be required.

Next, with the knowledge from previous years, we looked at the bottlenecks of understanding in the evaluation of the experiments. It turned out that students had very little idea of errors, how they are caused, how they influence an experiment, and then also to what extent their own data were trustworthy. We concluded that two things were needed: first, an improved technical knowledge of statistics and Excel, and second, a totally different way of evaluating experiments. To address the first, we introduced two additional theory days, one for statistics (in presence, with a custom-written statistics script of 40 pages) and one for Excel (online on Teams). These, we hope, will have lasting effects on the students' ability to deal with data, including in their internships and later careers. Those three 'theory days' were useful because they gave us a chance, also, to bring, during the pandemic, the entire course together, since the lab was only certified for 1/3 (2021) or ½ (2022) of the students in the course.

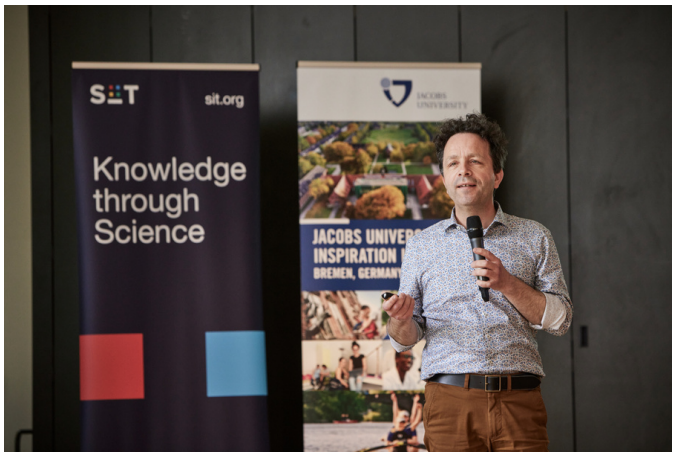
For the second item, we totally redesigned the evaluation parts of the lab manuals, making them more like a 'guided tour' or a 'conversation', where students are led step-by-step from one observation to the other, answering specific questions and filling in specific data rather than writing free text. This follows the general Jacobs philosophy of making students perform at the first attempt, rather than failing them and forcing them to try again. It has been generally successful in the two years it was tried, with the side effect of also making the lab reports easier to grade for the teaching assistants, enabling them to focus more on the students.

From this, it emerged that we needed to focus much more on quantitative results to sharpen students' sense of accurary and of the meaning of their own data. This we achieved by asking students to compare the results of different groups (instead of performing extensive repeats, for which there was no time), and by setting up experiments such that only through the work of several groups together, a meaningful set of data would be achieved.

"Redesigning a Biochemistry Laboratory Course"

The final teaching assessments regarding the course were very positive. In the end, the project did not achieve its initial objectives of totally inverting the laboratory course, but realized that within the boundaries of the Jacobs ecosystem, this is impossible. When we refocused it to delivering the existing content as efficiently as possible, and especially ensuring maximum preparation for the experiment and its professional workup, we came to a course that was significantly improved and gave students a sense of achievement.

There are several projects for the next few years to further develop and refine the course. One problem is that of course, without the substantial financial support by the Foundation, the kind of intense student supervision enjoyed in the last couple of years will no longer be feasible. Thus, we will probably drop the work-intensive lab manual writing exercise but continue to refine the lab experiments, especially with a view to expanding the numbers of students, which is a general aim across Jacobs University. We anticipate that the course will continue to develop.



Professor Sebastian Springer presenting project results at the “Final B3 Symposium”

"Lab@home – Concept Angleichung": a partial online teaching tool centered around problem-driven hands-on experimentation

Project Chair: Dr. Alexander Petrescu

The rise of online teaching prompted by the global pandemic implies that hands-on experiences such as laboratory courses, are becoming very hard to implement. Educators world-wide are urging for new and creative ways to successfully engage student interest and motivation across the boundary of the computer screen. In addition, current university lab courses often cover concepts that students don't have an immediate connection with, especially in classical subjects such as Physical-Chemistry or Biochemistry that can be rather abstract.

"Lab@home - Concept Angleichung" is intended to fill this gap as a partial online teaching tool centered around problem-driven hands-on experimentation. The proposed solution to bring the topic closer to the student is the newly coined "Concept Angleichung": "Angleichung" is a German word that can be translated as adjustment, alignment, adaptation, harmonization.

The idea is to adapt the scientific (abstract) concepts to something the students are already familiar with such as everyday experiences, phenomena, or objects by employing university-level experimental procedures and data analyses. If robust enough and easy to use, the method of analysis will include non-professional procedures and props developed especially for the course. A Physical-Chemistry/Biochemistry lab course is modernized by adding, for each taught concept, extra problem-driven experiments that have an element of familiarity meant to ease and solidify students' understanding. In most cases, the add-ons are designed to be done entirely online. After the experiments have been shown to be robust, challenging, engaging and efficient, they become stand-alone experiments that constitute a stand-alone course.

The student receives a box with safe equipment and materials and runs the experiment at their location while the instructor supervises online. The kit includes custom made cheap devices and an accompanying smartphone app to aid data collection and analysis. This is meant to further bridge the understanding gap on one hand, and to serve as proof-of-concept for online teaching of labs on the other.

“Lab@home – Concept Angleichung”: a partial online teaching tool centered around problem-driven hands-on experimentation

The innovative B^3 Lab@home - Concept Angleichung Project refers to the aligning/adapting/harmonizing of Physical-Chemical and Biochemistry concepts to the everyday experience of the students, through the addition of hands-on experiments, most of which taught online, within the format of a lab course.

Dr. Alexander Petrescu, Project Chair

Dr. Jakob Fruchtmann introduces the concept of the “Hybrid Neighborhood Museum” to the “Final B3 Symposium” audience

A view of the in-person audience of the "Final B3 Symposium". Many other participants attended online on June 14, 2022

Actor Boris Radivoj performs one of the migration narratives portrayed by the B3 Project “Hybrid Neighborhood Museum” for the Symposium audience

Prof. Dr. Bjørn-Tore Flåten from the University of Agder (Norway) presents his contribution at the B3 Symposium

Dr. Felix Becker from Technische Universität Braunschweig presents at the B3 Symposium

Guests exchanging impressions during the coffee break

Guests enjoying a short pause during the Final B3 Symposium

Participants exchange ideas at the Final B3 Symposium

Team members exchange impressions at the Symposium

Guests toast over wine for a successful conclusion of the “Final B3 Symposium”

Bildung Beyond Boundaries (B^3) Framework

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