TUM: Junge Akademie

Research Reports 2021
Disruption & Reconstruction
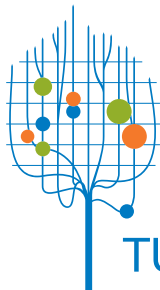
TUM: Junge Akademie

Research Reports 2021

Welcome to the *TUM: Junge Akademie*

This brochure presents the results of the project groups of the TUM: Junge Akademie 2021. This year the scholarship holders have translated the call "Disruption & Reconstruction – Opportunities for global collaboration" into a variety of inspiring projects. Originally the call encompassed three central aspects: Firstly, the current global challenges themselves; secondly, the fact that these require new solutions, approaches and procedures in many areas, accompanied by new and disruptive boundary conditions and new constraints for global competition; thirdly, and this became increasingly visible in 2022, the systemic polarization of the world, which in turn represents an enormous hurdle for global cooperation.

Thus, the call was very broad, which was a challenge for the scholarship holders. As a result, they mainly addressed the second aspect. Moreover, the individual ideas proposed at the start scattered in different interesting directions during the project work – perhaps more than in previous calls. Finally, the projects range from the tasks and challenges on the level of the individuum, addressing the question of how an individual change of perspective can be created and triggered (Culture), and how procrastination, the putting off of pending tasks, can be recognized and managed (Proactivation). On a societal level, the projects address the challenges of science communication (CreaThesis) and how scientific knowledge can be actively disseminated within society as a prerequisite for tackling urgent problems that range from climate change and the pandemic up to new forms of teaching and learning (elecTUM). Finally, one of the projects focuses on current disruptive changes in teaching and on formats that might be developed to handle and respond to them (LETO).

This year we were again impressed by how successfully the students managed to work together despite the pandemic, with very limited in-person presence and without the usual possibilities for retreats that are essential for a fruitful collaboration. Corona was quite definitely not a showstopper. This makes the results achieved by the students all the more remarkable.

Dear students:
We hope that you have gained a clear sense of our key aims and ambitions at the TUM: Junge Akademie.

Firstly, to bring you together, as a group of talented and creative students from different disciplines, and to support you in sorting and structuring your ideas under an overarching theme; secondly, to encourage and guide you in turning these ideas into concrete projects; and thirdly, to support you in producing a result that starts from a hypothesis that is tested using scientific methods and discussed using a concrete application or other tangible outcomes. Just as important as the project work are your observations and reflections on what is involved in inter- and transdisciplinary collaboration: What are the pitfalls in communication between disciplines, where are the unconscious biases that limit collaboration, and how can you identify them?

In the near future, your cohort will have the responsibility of identifying and weighing the short-, medium- and long-term challenges facing our societies and the planet Earth. You will be the group that will proactively shape developments for the better and will work on "wicked problems" whose solution parameters are broad and unclear. To do this, you will need to understand, analyze and balance conflicts of interest and act as moderators and communicators. You must be willing to cooperate and collaborate across and between disciplines, with mutual understanding and respect for other professional cultures, ways of thinking, and approaches to problem-solving. I am convinced that your involvement in the TUM: Junge Akademie will have provided you with a further foundation for your future tasks.

Dear mentors, tutors, and former members who have been involved in the projects: Thank you for your generous time, expertise, and kind advice, which were invaluable to the project groups.

And, finally, a big thank you to the TUM Board for supporting the format, to the manager Peter Finger and his team for their valuable and highly professional guidance, and to the members of the Task Forces, Board of Members, and Advisory Board for their creativity, commitment, and enthusiasm.

Enjoy reading this brochure and exploring the projects!

Yours sincerely,

Gerhard Müller
Vice President for Academic and Student Affairs

Dear TUM friends and associates,

Our students have the future in their hands! Their pioneering spirit, creativity and sense of responsibility fills the university with life and will enable them tackle the fast moving challenges of the modern world. For them success means to keep on learning and being flexible to changes throughout life. They will need to upgrade their skills continually to stay relevant, connected, and capable to collaborate with others.

Connected is the key word: This project book's focus is on networking. We have been able to witness the professional and personal growth of scholarship holders on their path to positions of importance in academia, politics as well as the business world. Our cohorts now have the opportunity to profit from these highly responsible tutors and supervisors by way of interviews and the mentoring program.
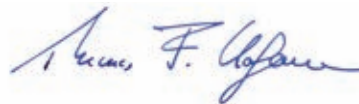
Over the last twelve years, the TUM.JA scholarship program has developed into a success story not just for the exceptionally talented and committed students themselves, but also for the university community as a whole. It is further prove that leading universities such as TUM serve as places of systematic reflection as well as engines of progress and are, therefore, prime movers of today's value-creation chain. TUM offers students an outstanding education that will pave the way to future careers, while completely focusing on their individual goals and realization of their potential. The aim is to provide the prospect to explore and discover their talents and strengths. One of the key benefits of the scholarship is to provide the safety necessary to pursue academic interests without having to think about limitations.
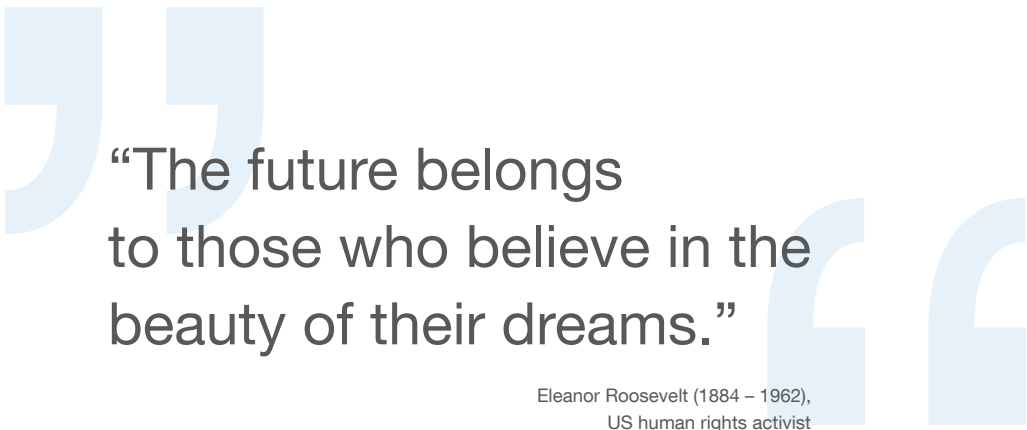
We are very proud of the entire TUM family involved, among them our dedicated students, staff, faculty professors and Emeriti of Excellence. My special thanks go to the former and current Senior Vice Presidents for Academic and Student Affairs Prof. Dr. Peter Gritzmann, Prof. Regine Keller and Prof. Dr.-Ing. Gerhard Müller; they were essential drivers of the successful development of this unique scholarship program. Furthermore, I want to thank our extensive interdisciplinary partner network – the HFF Hochschule für Fernsehen und Film, the Hochschule für Musik und Theater and the Akademie der Bildenden Künste.

As President of TUM, I would like to wish all TUMJA scholarship holders, alumni, friends and sponsors a high degree of curiosity, determination and most of all continued success!

Yours sincerely,

Thomas F. Hofmann
President

"The future belongs
to those who believe in the
beauty of their dreams."

Eleanor Roosevelt (1884 – 1962),
US human rights activist

TUM: Junge Akademie

Passion for Science

There are many supporting factors in getting to grips with science, and one of the most important ones is passion. The TUM: Junge Akademie offers passionate and committed students the opportunity to engage seriously with science for the first time. Their curiosity and desire to explore and fully immerse themselves in scientific issues is what unites TUMJA's scholarship holders. Being passionate about science helps students to face constant new challenges, to break down complex topics into manageable segments of knowledge and to recombine them into a coherent picture later on. With their projects, the TUMJA scholars contribute significantly to science and, at the same time, this contribution to science accomplishes an important contribution to society.

The TUM: Junge Akademie aspires to promote its scholarship holders in an integrated manner. Using the 20 months' duration of the program, the students and doctoral candidates plan and develop a self-chosen project within an interdisciplinary team. Our scholarship holders aim to find solutions for social issues, to enable creative innovations, and to review these in relation to their feasibility. Throughout this process, they are supported by top-class researchers, who guide them, from initially substantiating their project idea to concluding it as a final project report. Various workshops, such as for scientific and journalistic writing or project management, accompany the project work.

In addition to project work, the scholarship of the TUM: Junge Akademie includes an extensive supporting program with community and networking-forging events, inspiring excursions, and more. What makes this program so special is that the scholarship holders largely design it themselves, contribute their expertise to taskforces and, by doing this, develop their knowledge and personality. With their diverse skills and determined commitment, the scholarship holders also contribute to major events such as the TUM Science Hackathon, the TUM Campus Run or the annual Symposium.

This year's overarching call, "Disruption and Reconstruction," refers not only to the general inspiration for the project ideas. The call also applies to the project work itself, as not every project is a success, and sometimes it has to be modified along the way. That is also part of learning. However, numerous projects in recent years were so successful that other institutions adopted and continued the valuable work.
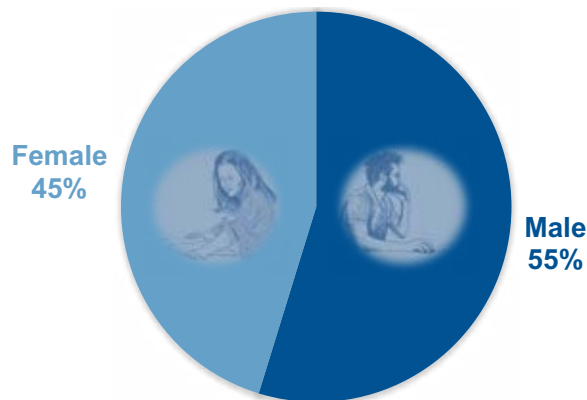
The TUMJA community includes eighty fellows and over 600 alumni, supervisors, and professors from four universities. The creativity of its members and the large community of highly motivated personalities have shaped the twelve-year history of TUMJA. We look forward to our community growing further over the next few decades. ■

Facts and Figures

The exceptionally talented and committed scholarship holders of the TUM: Junge Akademie reflect a great diversity in many ways. The class of 2021 represents a wide range of social, cultural and, above all, academic currents at TUM.

During the selection process for this class, 2,793 students – the outstanding 5.78 percent of all TUM students – received a nomination to apply for a TUMJA scholarship. In three information events, 600 interested students were able to get a detailed picture of what TUMJA has to offer. Eventually, TUMJA received 229 applications from nominated students. In addition, three initiative applications from LMU students and a further eight from TUM students arrived at TUMJA. Sifting through and pre-selecting the applications is not easy at all, as the best of the best now had to be selected. In a multi-stage application process, 76 young talents went through interviews regarding their motivation for science, research, and interdisciplinary cooperation and were invited to prove themselves in small work assignments. At the end of the selection days, 42 scholarship holders were accepted into the class of 2021.

After 20 months of enriching and valuable experiences, 37 students successfully completed their TUMJA scholarships. See their portraits on pages 26-32.
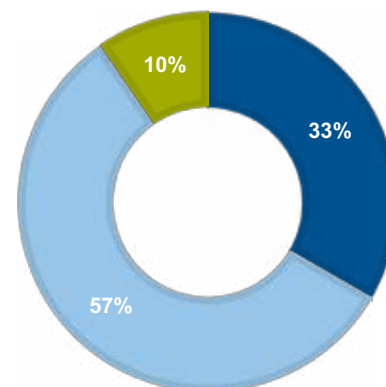
Sport and Health Science

TUM School of Engineering and Design

Mathematics   TUM School of Governance

Chemistry

Informatics

TUM School of Management

TUM School of Engineering and Design

Medicine

Physics   TUM School of Social Science and Technology

TUM School of Life Science   Electrical and Computer Engineering

Munich Institute of Integrated Materials, Energy and Process Engineering

The innovative and creative ideas of the teams also grow through interdisciplinary interaction. This year's scholarship holders come from 14 different fields of study.

In addition to new subject-related insights, younger scholarship holders in particular benefit immensely from working with more experienced students who have already gained an insight into the world of science. This year, 24 Master's students and four students with state examinations were happy to share their knowledge with 14 Bachelor's students.

STUDY DEGREE

■ Bachelor   ■ Master   ■ State examination

10%

33%

57%

Female 45%

Male 55%

As TUMJA sets a high value on equality, the new class consists of 23 male and 19 female scholarship holders.

42 students

1x Russia

33x Germany

1x Spain

1x Kosovo

1x Turkey

1x Italy

1x Albania

1x Morocco

1x Lebanon

1x Brazil

with 10 nationalities
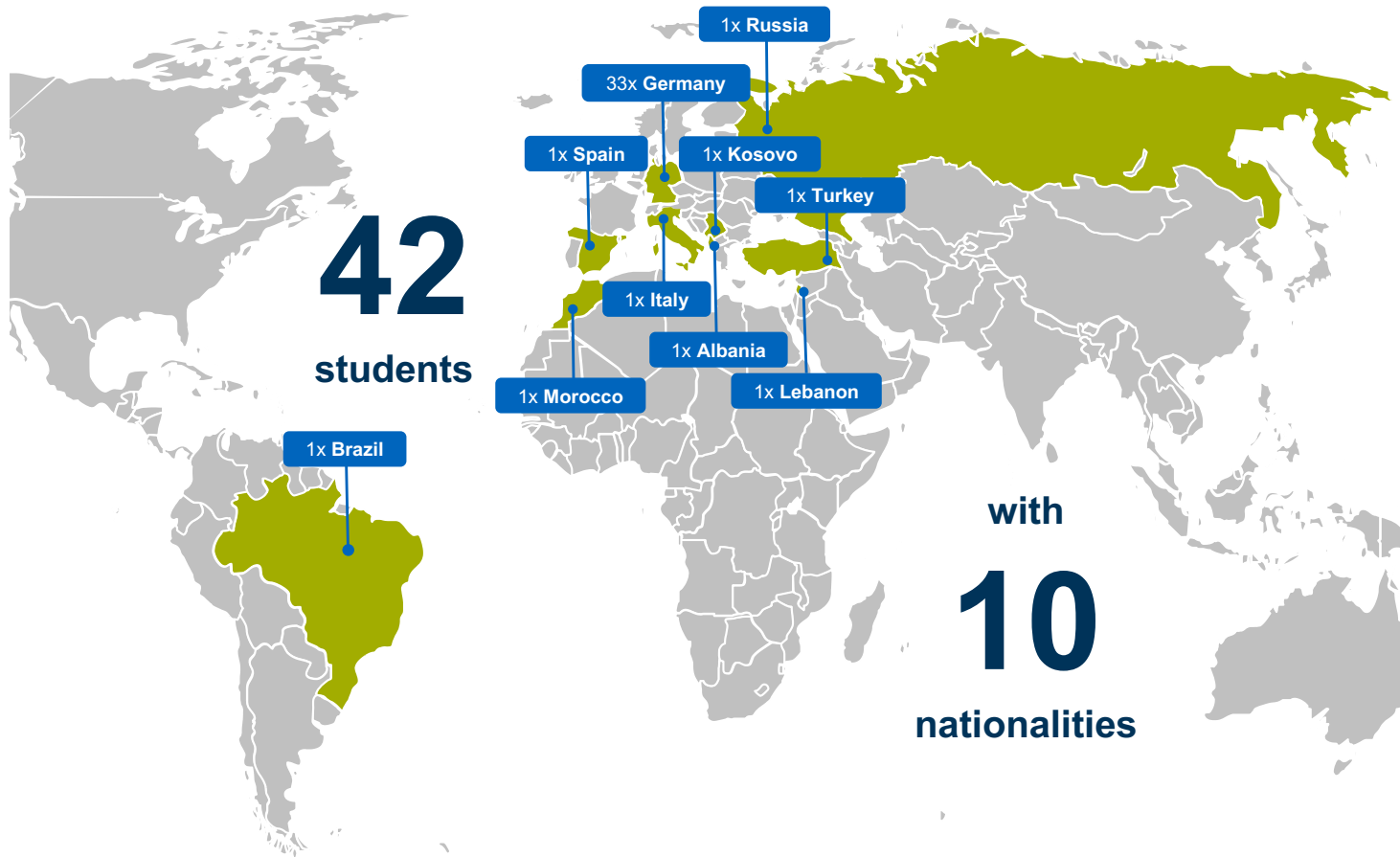
The diversity of the scholarship holders is also apparent in their origins, as the chart illustrates. The different international influences within the class opened up new perspectives and enriched the interdisciplinary cooperation with important intercultural aspects. ■

The Boards of the TUM: Junge Akademie

Advisory Board

Since the Academy's foundation in 2010, the Advisory Board represents the organizational unit of the TUM: Junge Akademie with decision-making power. The Advisory Board represents the Academy's governing body, whose members meet twice a year. Such meetings are important to ensure sustainable growth and overall effectiveness of the Academy. The Advisory Board primarily decides on the medium to long-term strategic and organizational issues of the TUM: Junge Akademie. Since 2016 the President of the University of Music and Performing Arts Munich, Prof. Bernd Redmann, and the President of the University of Television and Film Munich, Prof. Bettina Reitz, have further enriched the collaborative nature of the Advisory Board. A number of elected active and former scholarship holders of the TUM: Junge Akademie represent the scholarship holders' voices. These representatives, together with active and emeritus professors, constitute a distinguished board of experts, who complement each other perfectly in

> *"As a student representative, I want to make sure that the scholarship holders' opinion is equally taken into account in organizational decisions of the Advisory Board concerning the future of the TUM: Junge Akademie."*
>
> Monica Déchène

terms of their diverse knowledge. Their different backgrounds and skills encourage and support the exploration of new organizational ideas. The strategic themes include in particular the purpose and direction of the TUM: Junge Akademie as well as its interaction with TUM's several institutions and their programs, such as the Global and Alumni Office, the Corporate Communications Center (CCC), the Legal Office, TUM ForTe or the TUM University Foundation. Such collaborations and interchanges encourage the development of a governance framework that enables sustainable growth of the Academy. The Advisory Board also discusses proposals from the Board of Members. In addition, the Advisory Board is responsible for key operational tasks, which include the selection of new scholarship holders or the definition of possible project topics from the wide variety of submitted project ideas. The work of the Advisory Board is thus designed not only to generate new creative ideas, but also to provide challenging intellectual influences that can only enhance the program of the TUM: Junge Akademie. ∎

Director:
Prof. Dr.-Ing. Gerhard Müller,
Senior Vice President Academic and Student Affairs

Scholarship Representatives:
Monica Déchène
Saskia Hutschenreiter
Dr. Matthias Lehner
Stefan Lehner
Andrea Schittenhelm
Paul Sieber

Professors:
Prof. Dr. med. Pascal Berberat,
    TUM School of Medicine
Prof. Dr. Sonja Berensmeier,
    TUM Department of Mechanical Engineering
Prof. Dr. med. (em.) Michael Molls,
    Spokesperson Emeriti of Excellence
Prof. Dr. Ruth Müller,
    Munich Center for Technology in Society
Prof. Dr. Bernd Redmann,
    University of Music and Performing Arts Munich
Prof. Bettina Reitz,
    University of Television and Film Munich

Board of Members

The Board of Members represents an important unit in the network of the TUM: Junge Akademie. Networking is not about collecting contacts – it is about nurturing relationships. This is also the principle on which the BoM work is based. In order to strengthen this

> *"Together with Sophia, I represent all scholarship holders and lead discussions among the fellows. The entrepreneurial mindset of all of us motivates me to drive change within TUMJA, and to attract passionate students and new partners from industry and academia to our projects every year."*
>
> Philipp Patzelt

networking spirit, each project group and each taskforce sends one representative to the periodic meetings. The BoM meetings allow for a space in which to keep one another up to date, discuss ideas, give advice, and support each other to improve and further develop the TUM: Junge Akademie. Besides the regular visitors, all members and alumni are invited to join and contribute their experiences and opinions. The meetings offer a platform to synchronize the different groups and people and to achieve lively cooperation and synergy.

An important responsibility of the Board of Members is the election of six student representatives to the Advisory Board. By the integration of the Board of Members into the Advisory Board, the scholarship holders can actively participate in the decision-making process and thereby represent their interests. Proposals for changes in the scholarship program are handed to the Advisory Board, the director, and the office team. Together with the board, the scholarship holders are encouraged to take action and implement these changes. Last year, BoM members contributed to the amendment of the TUMJA Mission Statement, which the scholar representatives passed through the Advisory Board. Such achievements are usually preceded by discussions in the BoM, which, however, remain reasonable and always appreciative. In general, it is important that all contributions, opinions and wishes of the scholars and participants of the BoM are taken into account equally, since this is the best way to ensure that the TUM: Junge Akademie continues to flourish and to become the best it can be.

Speakers

Philipp Patzelt   Head of the Board of Members
Anna Sophia Schmid   Deputy Head of the Board of Members ■

> *"Together with Philipp, I have the fun task of connecting the scholarship holders with each other and with the administration. Furthermore, we are involved in developing new ideas on how TUMJA can be transformed to better meet the needs of the scholarship holders."*
>
> Anna Sophia Schmid

Mentoring Insights

The idea of networking within the TUM: Junge Akademie particularly benefits from the exchange of current and former scholarship holders. This intense interaction primarily takes place through the TUMJA internal mentoring program, which was founded in 2019. The scholarship holders are given the opportunity to receive a one-on-one mentorship from experienced TUMJA alumni. This creates not only a significant gain in knowledge for the mentees, but also the opportunity for the alumni to stay in touch with their alma mater and to benefit from the dedication and knowledge of new generations.

In the following report, we would like to introduce one of the 19 mentoring tandems of class 2021 in more detail and share their experiences. Our mentee is Catherine Yngaunis Koch, #class21

scholarship holder in the project group "elecTUM." She is the deputy of Taskforce Event and is also in charge of Munich's Initiatives Evening (M!A) organized by TUMJA. Her mentor is Carlotta Ferri, TUMJA alumni of the year 2017/I from the project group "Politics and Fun (PiA)." One thing both project ideas have in common is the idea of sustainability. Catherine's project targeted more sustainable energy consumption among students and Carlotta's project addressed the sustainable impact of politics on students' daily lives.

We appreciate the responses to the interview questions from the mentoring tandem and the collaboration with Taskforce Mentoring, which you can read more about in the final section of this book.

Mentee	Catherine Yngaunis Koch	
Faculty	TUM School of Engineering and Design	
Course of Study	Energy and Process Engineering (M.A.)	
Place	Munich, Germany	
Short Vita	2021	Volunteer at JUNO, supporting female refugees
	2020	Tutor at TUM for Higher Mathematics
	2019	Deutschlandstipendium Summer School, focus on sustainability
	2017	Abitur at Colégio Visconde de Porto Seguro, Brazil

Mentor	Carlotta Ferri	
Faculty	TUM School of Engineering and Design	
Course of Study	Environmental Engineering, Sustainable Energy Technology	
Place	Eindhoven, Netherlands	
Short Vita	2021	Junior Project Manager at Statkraft, leading company in hydropower
	2019	Master's degree at Delft University of Technology
	2018	Intern at Fraunhofer Institute for Energy Economics and Energy System Technology
	2017	Bachelor's degree at Technical University Munich

What was the best mentoring moment?

Mentee: At the time of our first mentoring meeting, I was looking for an internship. After talking to my mentor about it, she was very supportive. During our meeting, she gave me several tips regarding the topic. After that, she looked for contacts that she had and would be interesting for me. To know that I was getting that much support from her was very special to me.

How did the first meeting go?

Mentee: Our first meeting was online since my mentor lives and works in the Netherlands. However, even online, we got to know each other very well, in my opinion. At the beginning, we introduced ourselves better than we had previously done in the introductory meeting. After that, we talked extensively about my mentor's education and career paths, and about my plans and doubts for the future.

What is the importance of the TUMJA network to you?

Mentee: The TUMJA network facilitated contact with other members of the TUM community apart from those in my study course. With that, I got to know people with skills, ages, and backgrounds other than those I was used to.

How were you able to benefit from the mentoring individually?

Mentee: Through the mentoring experience at TUMJA, I learned that there are several people out there willing to give you great advice and support. With Carlotta as my mentor, I had a great first-hand experience that proved the veracity of this lesson. I am certain that, even when the official mentoring from TUMJA ends, Carlotta is still going to be willing to help me where she can.

Mentor: It was for myself a bit challenging to help Catherine because I could recognize my personal experience in hers, with all the good and more difficult aspects that this moment of her life brings. I think I benefit from the mentoring program in a way because it gives me the chance to look back at the person I was when I had to take certain decisions and it helped me to look at the choices that I am facing now with a different perspective.

What was especially important to you?

Mentee: When choosing Carlotta as my mentor (she was my first option), I considered three different aspects. First, I wanted to have a mentor who worked in industry – not in academia – since this is the path that I want to follow in my future. Second, I was very keen to see that Carlotta works with renewable energy, which is a topic I want to focus more on during my master's degree program. Third, I was very inspired by the fact that she, just like me, is a non-German woman who moved to Germany with the aim of becoming an engineer. ◾

Catherine, Mentee

Carlotta, Mentor

Alumni Interviews

Dr. Valerie Domcke in an interview with **Niklas Dreymann and David Noachtar**

Short CV:

- Previous TUMJA program "Erfahrene Wege in die Forschung"

- Study focus on theoretical physics at TUM

- Doctorate at the Deutsche Elektronen-Synchotron (DESY)

- Works in the field of particle physics and cosmology at CERN

Niklas: *What inspires you and what drives you most in life?*

Valerie: Let's start with physics, what's driving and motivating me. I would say that it is the really big open questions: Where do we come from - where are we going? What is the origin of the universe? What are the fundamental laws of nature and forces that describe the world around us? These are really the fundamental questions to which we don't have answers yet, or have so many different answers, and don't know which one is the right one. That is the motivation that drives me in my research.

Even back in school, I found black holes and dark matter totally exciting because it seemed so unknown. So unfamiliar and yet so fundamental at the same time. In my studies, I enjoyed theoretical physics a lot, I listened to the corresponding lectures, and at some point I chose my master's thesis accordingly. Then I realized, wow, you're really doing exactly what you dreamed of in school.

David: *Could you briefly summarize your research area and describe a typical day at work, what it looks like with and without Covid?*

Valerie: My research area lies at the interface between particle physics and cosmology. The idea is that the universe as we know it today is expanding. As it expands, it cools. That means that in very early times, the temperature in the universe, or the energy available to particles in the universe, was much higher than it is now. And so, in a sense, the earlier universe is a kind of laboratory where we can test the characteristics of physics. We can achieve much higher energies than we can ever do on earth with a particle accelerator. That's complementary to the experiments we do on Earth, and that gives us a gateway to test physics at extremely high powers. How that looks in practice is that I usually start in a team of three or four people from existing models, or from specific unresolved questions. From that, we design possible extensions to the standard model of particle physics, and calculate the predictions and consequences for cosmology, in particular whether you can derive any observable things from it. Then one can investigate whether one sees or does not see such things. Even if you don't see it, you can then put some constraints on certain parameters as a result.

Niklas: *Let's talk about time at TUM, your experience with the TUM: Junge Akademie or its previous program. What do you remember most fondly when you think about that time?*

Valerie: Well, actually, my best memories are of us working in small groups until late at night, grinding our teeth on some worksheets. Now that sounds a little weird, that being a good memory. But it was all about teamwork and I made friends that I still have today. What I remember was getting in touch with motivated young people from different disciplines, simply looking beyond my own horizon and experiencing very interesting discussions. ∎

Patrick Christ in an interview with **David Noachtar and Elena Tangocci**

Short CV:

- TUMJA class 2010 / 2011

- Study of physics at TUM

- Doctorate at the Center for Digital Technology and Management (CDTM)

- Managing director of the company Capmo, which he co-founded

Elena: *What character traits have helped you the most to be where you are now?*
Patrick: Creativity paired with determination, not doing what everyone else is doing, but taking a new path, has especially helped me. But beyond that, the ability to rather take a step back to find new ways of thinking to solve deadlocked problems. My enthusiasm lies in developing new things and taking them further.

David: *How did you get into the field of artificial intelligence and subsequently Capmo after studying physics?*
Patrick: I always had an affinity for IT and programming, but I decided to study physics. The subject is multileveled and provides fundamental scientific knowledge and analytical skills. In the course of my studies, I realized that computer science is my passion. At the same time, I find it extremely exciting to start and push something forward on my own. At the end of my studies, I therefore decided to found my first start-up together with a fellow student. At that point, I had already been considering self-employment for a while and I liked the idea of building something together with a friend. So we founded Demoskopia, which still exists today. The goal of Demoskopia is to measure patient satisfaction with a tablet app. I decided to go back to university to do a doctorate after I had founded the company. I found a PhD position at CDTM, which is an institute from TUM and LMU. Its goal is to offer an additional degree program combining technology and management. The exciting thing about CDTM was that you are relatively free in the area of your research. I had Prof. Diepold as my co-doctoral advisor, who was also involved with TUM: Junge Akademie for a long time. He is a very inspiring and supportive PhD supervisor who enabled me to deepen the topics in research that I found particularly fascinating – namely the areas of artificial intelligence and deep learning. It was at CDTM that I met my three co-founders of Capmo. They were initially my students, and when the four of us had finished our master's theses and doctorates together, we decided to found a new start-up together. We wanted finally to put the skills and methods we learned at CDTM into practice. We spent three months analyzing markets, identifying problems and conducting interviews in different markets. In this way, we identified the problems in the construction industry that Capmo solves today.

Elena: *To what extent has TUMJA influenced your career so far?*
Patrick: We were working on a very exciting project back then. The idea was to use videos to answer questions about everyday life in a quick and understandable way, for example, why is the sky blue, why is a banana crooked, etc. Another special experience at TUMJA is the work in interdisciplinary teams. My group included mechanical engineers, sports scientists, and economists. Everyone can contribute their strengths and the team benefits as a whole. This knowledge still helps me today. ■

Andrea Geipel in an interview with David Noachtar and Elena Tangocci

Short CV:

■ TUMJA class 2010 / 2011

■ Study of sports sciences at TUM

■ Doctorate in the field of science communication

■ Works as a research assistant at the Deutsches Museum

Elena: *Why did you choose a career in science? What drives you there?*

Andrea: I don't want to stop learning new things. That is what drives me to stay in science, or at the interface between science and culture. I would say the collaboration with different people drives me, meaning people from different cultures, disciplines, and specializations. That's an aspect I always encounter in my projects, and especially in the ones I like doing the most.

David: *The Deutsches Museum is known for combining the two aspects of "Technology and Arts." For you, what role does art play in the process of communicating new technologies and science in general?*

Andrea: More and more in the last few years. In the beginning, I always tried strictly to separate it – which means my own creativity and my work – because I felt that it had to be separate and that one didn't go with the other. When I was studying sport sciences, I sketched the different functional parts of the brain for an exam and then colored them. That just helped me with studying. But that was always separated from the "real work." In the course of my doctorate, however, I realized that the two aspects – art & technology or art & science – definitely go together. Art can help to visualize complex interrelationships, to reflect implications for society and, above all, it creates new approaches to these topics. Especially now at the Deutsches Museum, I have come to understand that art can, on the one hand, make complex topics tangible, but also, conversely, that art is not only there to communicate science and

technology, but also to advance science and technology. In my case, the field of art is often implemented through virtual reality technology. I couldn't help but get involved with it, as the head of the VR Lab. In the first month, I tried to figure out what already exists, and how I could use VR. There are of course many applications in the gaming sector. But artistic installations in particular are also finding new ways of communicating science and technology. I've been to a lot of events and talked to artists and learned a lot about how to approach digital storytelling. But it's actually much more interesting to play with what's possible with the new medium. For example, we have a steam engine where you can stick your head into a steam boiler and see where steam enters and where it leaves. It's really great to be able to think about things like that and make connections and processes easier to understand.

Elena: *What moments from your time at the Junge Akademie do you remember most fondly?*

Andrea: I think all of the fun events that developed little by little. For example, the first symposium that Daniel, Bea and I organized back then. There were many great moments in that. First times are always special moments, so I immediately have the image of that conference in my mind. I also think of our first hike, even though very few people had signed up. That's because it was the very beginning. And led to such great events as the Running Dinner. ■

Prof. Dr. Matthias Geuß in an interview with Annabel Matz and Tobias Tiemeier

Short CV:

- Previous TUMJA program "Erfahrene Wege in die Forschung"

- Studies of mechanical engineering and economics

- Doctorate at the TUM Chair of Automatic Control Engineering

- Professor for embedded systems at Hochschule Coburg

Tobias: *We'd like to talk about your academic career. When you were in school, were you already interested in natural sciences and technology?*
Matthias: Yes, I was particularly interested in the natural sciences and technology subjects. Above all, I enjoyed it when you were allowed to experiment on your own. And a personal highlight was my participation in "Jugend forscht," where I designed a biological photovoltaic cell. During my time at school, I also attended taster courses at various universities for orientation purposes, and in the end I found the topics of mobility, robotics and energy efficiency to be the most exciting. TUM is a leader in mechanical engineering, covers all of these aspects and offers many more opportunities. That's why I decided to study there, and I haven't regretted it yet.

Annabel: *Why did you finally decide to go into academia? You are now at a university of applied sciences. What is the main difference from a mainstream university in your daily work?*
Matthias: During my studies, I was a tutor for a long time, which I really enjoyed. I missed this aspect of teaching during my time in industry. On the other hand, I wouldn't want to miss working on innovative topics. As a professor at a university of applied sciences, you can combine teaching and practical research very well. In the end, the opportunity for this position emerged.

Basically, the activities, namely teaching, research and involvement in self-governance, are the same. In the past, the two institutions have converged a lot and are getting closer more and more. Nevertheless, there are of course a few differences. In terms of teaching, it's generally the case that you take on more courses at a university of applied sciences. In addition, you usually take care of everything yourself, i.e. you create the documents, prepare exams, conduct them, correct them, set up internships, hold exercises, supervise student research projects, and so on. In addition, there are no traditional frontal lectures like at a university, but so-called seminar-style teaching with comparatively small groups and a lot of interaction between professors and students. The contact between professors and students is much closer than it was for me during my studies. The research is also more application-oriented and is often conducted together with medium-sized regional companies.

Tobias: *We would like to talk about what brings us together here, namely the TUM: Junge Akademie. Were you able to benefit from the network that TUMJA provided you?*
Matthias: I can still remember various fireplace discussions with company representatives. I found it fascinating that heads of departments, board members and supervisory directors actually took the time to discuss current issues with us. I also remember the conversations with my mentor, Professor Mayinger. We talked about my studies and my own goals, among other things, during our meetings. When things worked out, he would then introduce me to other professors. That's how I ended up with a student assistant job and, in a roundabout way, with my semester abroad at the University of Cambridge. I was also able to learn a lot from him about the work of a professor. ∎

Trainer Portraits

The scholarship holders are shadowed by various trainers during their 20-month project phase. The TUM: Junge Akademie scholarship is not only aimed at providing first insights into science, but also supports the students in further developing their "soft" skills. In a comprehensively designed program, the scholarship holders receive valuable tips and tricks on the topics of presenting proficiently, communicating visually, reporting captivatingly, writing scientifically, and self-presentation through videos. Without the commitment of our trainers, the personal development of the scholars in these areas would be nowhere near as good as it currently is. In the following short profiles, we would like to introduce our committed trainers and take this opportunity to thank them once again for their excellent cooperation.
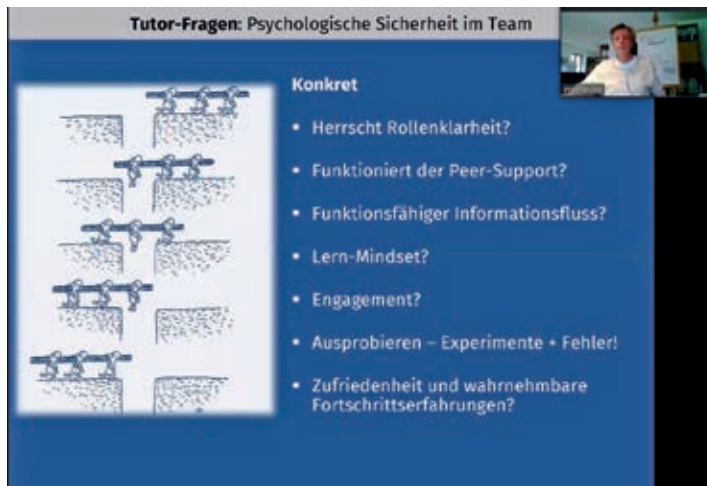
Pit Forster

"My personal drive is to perform authentically, to offer multiple stimuli, to be one myself. What is presented inspires, creates purpose, conveys meaningfulness."

Pit Forster is managing partner of Forum Momentum, an unconventional, dynamic training and consulting company. His focus addresses successful presenting in higher education and university environments. After studying educational and communication sciences as well as psychology, he worked as a research assistant for empirical pedagogy and educational psychology at Ludwig Maximilian University (LMU) and the Bundeswehr University in Munich. He is, he explains, mainly engaged in elegant, effective and efficient cooperation in complex business contexts; creative-innovative project development and its concrete implementation in organizations; and the art of teaching combined with the desire to learn and vice versa, especially in universities and academic settings. The scholars can benefit particularly from his training in the area of self-management and self-competence. From the beginning of his career, motivation and interest have been defining factors in his life, which is why he is now even more enthusiastic about passing on his skills in creativity, innovation and the practice of successful communication to the scholars.

Wolfgang Irber

"Good ideas in science also deserve good pictures, not only to be heard but also to be seen."

Dr. Wolfgang Irber is self-employed in business illustration and consulting enterprises in visualizing visions and strategies. His enthusiasm for science began at an early age when he studied geology at TUM. He continued his passion at the Freie Universität Berlin, where he received his doctorate with a focus on deposits and fluid-rock interactions. He suggests that one of his special skills has

been the talent of seamlessly moving from geology to telecommunication to leadership to business illustration. The love for drawing and art, which has accompanied him since childhood, brought him to the field of visual communication, where he has independently taught himself all the necessary additional skills. Among his customers are many well-known companies such as SAP, BMW, Audi, Infineon, Siemens, Volkswagen and Bosch. The scholars can benefit from his experience and learn how to communicate better by addressing all of people's senses and using pens to communicate more effectively in a professional environment. Since the Technical University of Munich is Wolfgang Irber's alma mater, he was easily motivated to cooperate with TUMJA. From his own experience, he noticed that there is great potential for improvement in science communication among researchers.

Victoria Treßel

"Clear, effective writing turns research into a conversation that can delight beyond its initial realm."

Victoria Treßel is a doctoral candidate at the Chair of Financial Management and Capital Markets. Having attended an English school, she was raised fully bilingually and with an appreciation for English language and literature. After joining TUM, she began working at the TUM English Writing Center, where she also extended her own formal writing skills. As a writing consultant, she coached students on their bachelor's, master's, and doctoral theses. She also performed CV checks at career fairs. She firmly believes that writing is a skill that can be learned by anyone if well conveyed. Now, as an academic, she enjoys crafting her own papers and teaching TUMJA students how to write impactful introductions. A former TUMJA student herself, Victoria appreciates this opportunity to give back to the scholarship program and hopes to help scholarship holders find joy in the art of writing.

Thomas Fromm

"I am particularly interested in how economics affects people – and vice versa."

Thomas Fromm is a business reporter with the Süddeutsche Zeitung. Since 2007, he has been writing articles for this newspaper dealing with globalization, industry, foreign trade, inflation, the military industry and financial policies. He has acquired the expertise and knowledge necessary to cover this broad range of topics through various educational programs. Thomas Fromm holds a diploma in journalism and a Master of Arts in political science. He pursued his desire to convey important news at an early age, when he was a radio reporter for the German Public Radio Stations Westdeutscher Rundfunk and Deutschlandfunk. He then worked for the Financial Times in Germany, and as Italy Correspondent in Milano for Business and Politics. In the TUM: Junge Akademie he supports the scholars yearly in workshops with the preparation of their "Journalistic Parts" for the project book. His profound ex-

perience in journalism, news-reporting, in depth and investigative research can be put to perfect use in these workshops. He enjoys working with students and giving them insights on how modern media/newspapers work. He is happy to share his experience in writing, research, commenting on current issues and finding appropriate ways to get messages and information across.

Jonas Neumann

"In my film 'Looking into the Void' I wanted to acknowledge the emptiness of the concentration camp memorials, which was left behind by time and the murders, and to fill it to a certain extent."

Jonas Neumann currently works as a freelance director and as an artistic-scientific assistant at the University of Television and Film Munich (HFF). In his past career, he worked at the Dachau Concentration Camp Memorial Site for a voluntary year. Since then he has been associated with the Dachau Memorial Site as a freelance lecturer. This work at the concentration camp has had a strong in-fluence on him personally as well as on his artwork. In his first film "Looking into the Void" he addresses artistic testimonies of survivors of the Shoah. The focus of his film was on Auschwitz survivor Batsheva Dagan and her poetry. He studied theater and philosophy at the LMU and then documentary film directing at the HFF. After successfully completing his studies, he worked for one year as a video journalist at the Bavarian State Chancellery. The TUM: Junge Akademie can also benefit from his current work as a freelance director and artistic-scientific assistant. In his video workshops, he teaches the scholarship holders how to express their ideas and themselves in the best way possible. The students can also benefit from an interdisciplinary exchange with Jonas Neumann as a representative of one of TUMJA's partner universities, the HFF.

Markus Walsch

"I really enjoy working creatively together with young, brilliant and motivated people from all over the world. That's what makes TUM-JA so inspiring and exciting for me."

Markus Walsch is an author and journalist, digital media producer and coach. He wrote for newspapers, studied economics in Regensburg and worked in public relations for BMW in South Africa, Deutsche Bank in Singapore and several advertising and event agencies. After completing his degree in economics, he initially focused on audiovisual journalism. He founded radioclick.de, Germany's first B2B online platform for radio content. Since the 1990s, he has developed a number of journalistic and fictional radio, TV and online formats for private and public media. He is not only a creator and author, but also a cameraman, sound and video producer, consultant and creative producer. Walsch develops and implements complex cross-media projects and also works as a coach and teacher for content marketing for universities. There is a humorous side to note about Markus – that, for more than 20 years, he's been known as a telephone prankster on the radio,

television and on the cabaret stage. For TUMJA, Markus started coaching in 2021. He contributed to the Arts & Technology call in the fields of storytelling and project management. TUMJA is very excited to have him on board again at this year's symposium.

Jörg Puls
"Success follows succeeded!"
Jörg Puls is the founder of the Institute for Vital Communication. He has studied acting, media marketing, and mediation/moderation. Bringing together soul, mind, and body is his passion. He teaches: Consciousness is the key to success. As a former Director for Corporate Culture and Internal Communications at Infineon Technologies AG, he learned a lot about the challenges of convincing in important meetings and events. For 20 years, Jörg has been working for the AUDI Academy as a Management trainer for vocal work, body language and presentation-Skills, and coaching teams in difficult situations. He is a German specialist in mediation for victims of sexual abuse and violence and is a group supervisor for teams working with refugees. He has been working as a radio

speaker and TV moderator, and since 2015, he has been coaching all speakers for a public TV science format called ARD Alpha Campus Talks. As a writer/singer/harmonica player, he is steadily publishing new songs and poems. He loves coaching and working for and with talented, motivated students: "Mental capability and strength is an obligation to take over responsibility for our human and biological society on planet earth". His Slogan: heart is king (or queen) – head is prime minister.

TUMJA Alumni
TUMJA thrives on knowledge transfer. Therefore, we encourage our alumni to pass on their knowledge as trainers for the new generations of scholarship holders. Numerous alumni are involved as trainers and help plan the curriculum. In charge of the knowledge transfer in project management and research methodology are currently TUMJA alumni Dr. Dominik Irber, Sebastian Kaltenbach, Dr. Matthias Lehner, Elena Tangocci, and Maryam Tatari. ∎

Management

The office staff of the TUM: Junge Akademie assist its scholarship holders in planning, organizing, implementing and evaluating their projects and ideas. This support can be quite diverse. Where one team needs assistance with technology, another team might just need the right people to get in touch with. The office pays special attention to networking and joint cooperation between all members. Together with the Taskforce Event, unforgettable experiences are created, such as visits to museums, running dinners or christmas parties in the premises of the TUM: Junge Akademie. The teams are free to use the premises and offices of the TUM: Junge Akademie. This makes it easier to hold project team or task force meetings. The recently renovated premises also invite you to spend some time together once the meetings are over.

The managing office, however, does not only take care of the concerns of the scholarship holders. The TUMJA management also serves as a point of contact to connect with other TUM-internal or external partners. It is always in close contact with its partners, such as the TUM Universitätsstiftung, the company Pixida and the 3 partner universities in Munich. Some of the core tasks primarily include administrative and financial matters. The planning, coordination and realization of major events also falls within the broad range of tasks of the office. Each year, the TUM: Junge Akademie hosts several extraordinary events: The TUM-wide "Tag der Initiativen," the Science Hack, or the annual TUM campus run.

The successful and smooth project work of the scholarship class of 2021 could only be accomplished with the support of each individual on the part of the scholarship holders, but also of the individual employees of the TUMJA office. We would like to pay special tribute to these efforts and present the individual gears that ensure the smooth running of the TUM: Junge Akademie.

■ The director of the TUM: Junge Akademie is Prof. Gerhard Müller. He is Vice President for Academic and Student Affairs at TUM and, in addition to his professorship for Structural Mechanics at TUM, coordinates the cooperation with the EuroTeQ Engineering University initiative.

■ The Managing Director Peter Finger has been continuously providing new ideas and improvements for the TUM: Junge Akademie since 2012. He passes his enthusiasm for science as a diploma agricultural engineer on to his ambitious scholarship holders.

■ The amazing administrative staff member Isabell Bopp trained as a management assistant for Tourism & Leisure. With her experience as a teacher in Africa, she manages to keep an eye on the big picture and important deadlines even in chaotic and hectic situations.

■ The field of public relations and event management falls within the responsibilities of Constanze Kukula. She ensures that the TUM: Junge Akademie always presents itself at its best, both on the website and in its publications, such as this annual project book.

■ In addition, student assistants Selin Yagmur Eroglu, Shubechha Paudyal and Monica Déchène actively supported the office during the scholarship class of 2021. ■

Faces

Scholarship Holders 2021

Christian **Dietz**

Proactivation
Mathematics in Science
and Engineering

Learning how the world around us works enables us to make the best possible decisions in everyday life.

Maroua **El Asri**

elecTUM
Sustainable Resource
Management

The weekend seminars were the best moments of TUMJA as it allowed us to interact in big groups, challenge our ideas and perceptions as a team and get valuable feedback.

Musa **Altun**

Culture
Consumer Science

There is a sense of obligation I feel having been granted the privilege of higher education.

Alix **Bertrand**

CreaThesis

My best moment at TUMJA was, when our team met for the first time in person after endless virtual meetings.

Dario **D'Alò Fonseca**

Proactivation
Biochemistry

The TUMJA scholarship allowed me to get further insights into scientific work and project managment which could both be very valuable for my future.

Marlon **Demandt**

CreaThesis

Fake news are a fundamental danger to today's society and can spread faster than facts. No one is really safe from being misled, but science, in my opinion, is the best guidance we have.

Theresa **Franz**

CreaThesis
Biomedical Neuroscience
(M.Sc.)

Both in the project and in my studies, I try to make a small contribution to the large field of science today, and I enjoy the work and the challenges it presents.

Leonardo **Giannotti**

Proactivation
Political Science

Through my scholarship at the TUMJA I was able to learn and improve many (new) skills such as team work or independent project planning which will surely help my professional career.

Mohammad **Hashem**
Culture
Masters in Management (MiM)

Science is the secret of advancement. Being a curious learner, science helps me step ahead to uncover the reasons of occurrences within themes I regard as appealing.

Lisa Magdalena Sophie **Henicz**
Culture

I see great potential in the interaction of young academics from diverse programs and backgrounds. I was excited to learn from other students how they communicate thoughts, structure ideas and spark creativity.
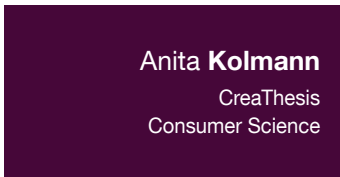
Anita **Kolmann**
CreaThesis
Consumer Science

For me, science means not being satisfied with the status quo. I appreciate being part of the quest for the new.

Joachim **Leibold**
elecTUM

I personally enjoyed the cultural activities like guided museum tours that come with the TUM-JA scholarship.

Nico **Michel**
CreaThesis
Mechatronics and Robotics
M. Sc.

The unique experience of working in an interdisciplinary team, becoming friends and seeing the result of our great project. I will always remember the fun we had during weekend seminars and meetings!

Genoveva **Müller**
Proactivation

My best TUMJA moment was finally meeting my team in person after all the remote meetings and seminars. This experience increased our motivation incredibly and brought us closer together.

Alexander **Holas**

elecTUM
Astronomy and Astrophysics

It is not every day that you get the opportunity to engage with people and topics outside your own field of studies and as such, TUMJA provides a rare chance to broaden your horizon.

Daniel **Khadra**

Proactivation
Electrical Engineering and Information technologie

My most exciting contacts were my teammates. I loved the interdisciplinary exchange and especially that many turned out to be great friends now.
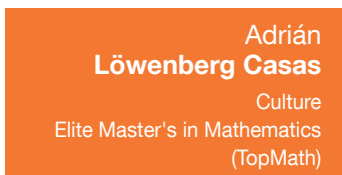
Adrián **Löwenberg Casas**

Culture
Elite Master's in Mathematics (TopMath)

Scientific research and thinking, especially in an interdisciplinary fashion, is not only a rewarding exercise by itself, but also helps me shape my contribution to society.

Annabel **Matz**

Culture
M.Sc. Maschinenwesen

What fascinates me about research is that it contributes to solving the most urgent problems of our society. At the same time, you are surrounded by inspiring people, and you can grow with them.
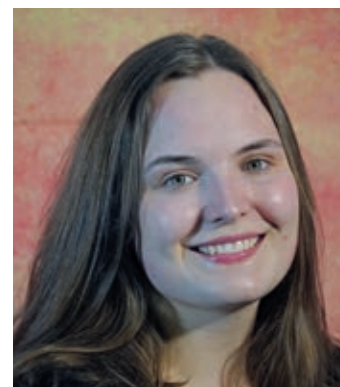
Philipp **Patzelt**

LETO
Health Science (B.Sc.)

Every year, research expands the foundation on which healthcare and allied professionals operate. I am driven to contribute to this field that can help people live happier, healthier and longer lives.

Alesia **Prendi**

elecTUM

The TUMJA scholarship was a very rewarding experience, I was able to build my confidence in working with different disciplines and learn how to start a project and progress over time.

Sara-Luisa Reh

LETO
Medicine (Stx), Biomedical
Engineering and Medical
Physics (M.Sc.)

I find it exciting to work on un-resolved problems and I love to discover new things.

Elisa Rodepeter

Proactivation

My motivation for science is curiosity, and working together in a team with people who feel the same way about it.
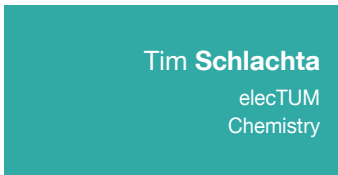
Tim Schlachta

elecTUM
Chemistry

Global problems such as climate change require global solutions. Interdisciplinary co-operation between all stake-holders is necessary. Thinking outside the box was my motivation to join TUMJA.

Anna Sophia Schmid

elecTUM

I am glad that I had the chance to meet so many motivated students from different fields of study! In addition, all our coaches designed very interesting workshops from which I could learn a lot.

Oliver Schurius

Proactivation
Physics

In my view, the human mind is a way for the universe to experience itself. Being in this lucky role, I see it as a duty to learn everything there is to learn about the world.

Philipp Strobl

CreaThesis
Biology

The enthusiasm to discover something new and have a positive impact on medical health research is my motivation for science.

Valentin **Roth**

LETO
BSc Management & Technology

Nature is complex, complicated, and creative. Witnessing the technological progress that is an outcome of studying this source of inspiration is my main motivation during the scientific process.

Andrea **Schittenhelm**

CreaThesis
Alumna (start TUMJA in Master program Sport & Exercise Science)

I am curious and doing research fits perfectly. Additionally, I am more of a passionate pessimist and at some point, I realized I should rather be part of a solution and not just point out problems.

Eva-Madeleine **Schmidt**

Culture

Understanding and drawing attention to underrepresented topics or issues as well as elaborating and presenting respective solutions.

Leonard **Schmitt**

elecTUM
Medicine

While I met many inspiring people, the most enriching contacts were surely with the members of my project team. Interdisciplinary work is rare, but so important to discover other viewpoints.

Wolf **Thieme**

LETO
Informatics

Sating my curiosity and finding beautifully over-engineered solutions to problems that lesser minds would consider already solved.

Tobias **Tiemeier**

CreaThesis
M.Sc. Consumer Science

For me, the best moment was meeting all the scholarship holders in person when the pandemic slowly ended. The interesting, in-person conversations were often eye-opening.

Josephine Van Delden
Culture

I like discovering the unknown unknowns instead of working on what we already know.

Niclas Weddigen
Culture
Technology and Management

The TUMJA scholarship helped me escape my "Management bubble" and inspired me to think outside the box.

Luca Mattes Wiehe
LETO
B.Sc. Management & Technology

Science and research means fully understanding a topic. Understanding the world together with curiosity has been my life's main driver since my childhood.

Laura Willinger
Proactivation
Health Science

I think research is so important to provide the best possible outcome for individuals and the society.

Catherine
Yngaunis Koch
elecTUM
Energy and Process Engineering

With the scholarship, I learnt how to do science inside a research group and how to face conflicts in this context. This gave me valuable insights regarding group work in a professional environment!

Tutors

Panagiotis Christou
Culture
Electrical and
Computer Engineering

Supporting the personal growth of a team through expanding its potentials was a great experience.

Ho Huang
Proactivation
Sports- and Health Science

I have many great memories with TUMJA. TUMJA is not only a family-like place to me, but also a wonderful learning environment.

Saskia Hutschenreiter
Proactivation
TUM School of Management

I love seeing the teams grow and develop not only ideas, but friendships.

Sebastian Kaltenbach
CreaThesis
Mechanical Engineering

TUMJA offers its members an unique combination of science, teamwork and personal growth. My best TUMJA moments were moments when the teams had fun while overcoming challenges together.

Dr. Matthias Lehner
LETO
TUM EDU

It is fascinating to see our highly motivated scholarship holders working on their projects together. Because of that, it is always pleasant to support them.

Elena Tangocci
LETO
TUM EDU

Always get engaged and make the best about it. This is the best way to have great experiences and learn both about new topics and about yourself.
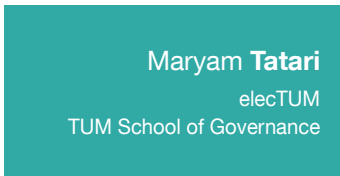
Maryam Tatari
elecTUM
TUM School of Governance

Conducting interdisciplinary research can get extremely hard, but worth it!

Samuel Valenzuela
Culture
Informatics

In my opinion, the biggest value of scholarship programs is the network of ambitious and intelligent people in which everybody can learn from each other and make many diverse experiences.

Maximilian Wagner
CreaThesis
TUM GOV

Additionally to seeing the team work so well during the pandemic, communicating research more effectively nowadays is more important than ever, and Creathesis showed me new ways there.

Sebastian Zäpfel
elecTUM
Mechanical Engineering

It's not just about the result – but also about being able to communicate it adequately. Have fun, socialize and allow yourself to make mistakes.

Supervisors

Prof. Dr. Peter **Annighöfer**

elecTUM
Professorship for Forest
and Agroforest

I could observe a very interesting project, from the first idea to the final substantial report. I also enjoyed seeing and accompanying, how the group organized itself and how it made use of the various skills they had within the group.

Prof. Dr. Ilona **Grunwald Kadow**

Proactivation
Professorship for Neural Circuits
and Metabolism

Procrastination is a problem for most of us. The pandemic has exacerbated this situation further, in particular for students, due to lack of peer group interactions. It was a great experience to support the creative team in tackling this problem.

Prof. Dr. Sara **Leonhardt**

elecTUM
Professorship for
Plant-Insect Interactions

It was a great experience to supervise and work with the team. I was deeply impressed by their independent and incredibly well self-organized working schedule, which they maintained throughout the entire period.

Prof. Dr. Holger **Magel**

LETO
Professorship for Land
Management and Land Tenure
(Prof. emeritus)

I witnessed how highly motivated and competent young academics created something new to help their fellows. Is there something more beautiful than experiencing how knowledge and skills are passed on unselfishly to help others?

Prof. Dr. Ernst **Mayr**

CreaThesis
Professorship for Efficient
algorithms (Prof. emeritus)

Because of Covid, meetings have been online, which often made the exchanges less fine-grained. Nonetheless, I enjoyed the interaction very much. It is my strong hope that in-person meetings will be re-established as soon as possible.

Prof. Dr. Rolf **Moeckel**

CreaThesis
Professorship for
Travel Behavior

Great minds think alike! TUM-JA succeeded again to select a group of highly motivated and smart students who discussed openly and used the discourse to push ideas ahead.

Prof. Dr. Jürgen **Pfeffer**

LETO
Professorship for Computational
Social Science and Big Data

With the help of others, we learn and we grow.

Prof. Dr. Elisa **Resconi**

Culture
Professorship for Experimental
Physics with Cosmic Particles

It was very inspiring being a supervisor of the interdisciplinary and international team.

Prof. Dr. Martin **Werner**

Culture
Professorship for Big Geospatial
Data Management

The interdisciplinary exchange makes the TUM: Junge Akademie an important element of the university life at TUM.

Dr. Alexander **Zink**

Proactivation
TUM School of Medicine /
Dermatology and Allergology

TUMJA is a unique and amazing program. As a previous mentee and now as a mentor, I really enjoy the exciting TUMJA community and its interdisciplinary network which brings up fascinating solutions for common problems.

Projects 2021

Kennst Du die ganze Geschichte?

Project Report **Culture**

Polarization may have severe consequences on communities and individuals. To counteract negative consequences of group polarization, we aim to promote reflective opinion-forming, and the adoption of multiple perspectives. In this regard, we define multi-perspective thinking as the consideration of a variety of possible reasons, arguments, and perspectives, including those of an out-group, for instance, when evaluating a social situation or a person.

As we aim for a replicable, sustainable solution concept, we wanted to work with accessible, simple, and budget-friendly means in our solution approach. That is why we chose to work with posters.

Team   Musa Altun
              Mohammad Hashem
              Lisa Magdalena Sophie Henicz
              Adrián Löwenberg Casas
              Annabel Matz
              Eva-Madeleine Schmidt
              Josephine Van Delden
              Niclas Weddigen

Tutors   Panagiotis Christou
              Samuel Valenzuela

Supervisors   Prof. Dr. Elisa Resconi
              Prof. Dr. Martin Werner

Culture

Preface by the Supervisor

Prof. Dr. rer. nat. Martin Werner

I have been glad to support a team of young students on their endeavor trying to influence the way that the wider public is receiving stereo-typical communication in public space. Unfortunately, we have been working our way through the Corona lockdowns and, therefore, had online meetings regularly.

I am very glad of having been one of the supervisors of the team "Culture". The experience was very inspiring and I learnt at least as much as the team did. First, of course, about how stereotypes in the public are affecting our perception. It was very nice to see the group coming up with a media campaign in which a strong contrast between the expected emotions induced by a selected image of a person with a textual description of the situation of the person was used to raise awareness that what you see is often not a good model of the reality.

At least as much as we learned about our own biases and stereotypical perception, we learned about ourselves and our behavior in teams. Everyone in our team found a way to contribute to the

overall success in a different way. This is the interesting aspect about very diverse teams in which not a single joint understanding is available at first and needs to be created in meetings and by communication. I am convinced that every single team member enjoyed the situation of being in a completely open space and trying out herself inside a team. It was very nice to see how the group of different people with different backgrounds more and more converged into a team in which certain roles were taken and the needed decision processes have emerged.

As your supervisor, I want to express my deepest respect for each and everyone in this team: you did a great job on the following three aspects: first, the project outcome stands for itself, second, everyone has taken a big step in his personal development, and, third, we all can now feel salvaged from a team which can now continue to grow into friendships. Let us keep in contact and continue our way.

On how to meet Van Gogh and prevent world wars

Close your eyes and picture the following situation:
It is a dark but starry night and you are outside. A person appears in front of you and stares at you. He is wearing a dirty shirt and run-down pants. His glaze is empty, his face is pale. He is talking to himself. Some mumbles reach your ears, but most strikingly, the scent of alcohol hits your nose. Suddenly he starts screaming.

What do you do?
Will you run? He may be a psychopath, an alcoholic, a scary homeless guy. He could attack you! Or will you approach him and ask him for an autograph?
You are standing in front of one of the most famous painters of all times: Vincent Van Gogh.

This is what just happened: With the few available physical features, your brain evaluated the person you just saw. It compared the given stimulus with previous experiences you have had. The features of the man in front of you match with those of the scary group of people you frequently encounter at the subway entrance when you come home late at night. After just a few seconds, an opinion about the person was formed.

While being extremely helpful, this feature of our brain can sometimes be also quite misleading. What kept us alive 20,000 years ago might be an obstacle for our social life today. Back then, instantly categorizing people according to "danger" or "opportunity" was crucial for survival. Today, however, our world is more complex. There are not just friends or enemies. There are co-workers, bosses, customers, neighbors, strangers, old friends, close friends, easy-going friends, and so many more.

The depth and variety of people's lives and experiences have changed as well. During the Stone Age, you may have been able to describe a person in one page. Today, you could write entire books about people. Possibly even more than one: Just look how we present our different facets so vividly on different platforms: On LinkedIn we show what we have experienced and achieved in work life. On Instagram and Facebook, we present our private attitudes and feelings. On dating platforms we may try, again, to present ourselves in a different light. Our lives are complex, and so are we.

Bearing that in mind, judging and categorizing a person after having read just one page of their book would not really make any sense. But still, we do it. While being useful in certain situations, these evolutionary behaviors may also impact us negatively. On a higher level, when an entire society practices these behaviors, they can lead to exclusion and the formation of mutually hostile groups.

This phenomenon is described by the in-group/out-group concept: People go back to the most fundamental form of socialization, only differentiating between friends and enemies just like their predecessors 20,000 years ago. While strongly identifying with their in-group, individuals disassociate themselves from members of an out-group. As a consequence, interaction and discussion within in-groups comes with a tendency to extremize opinions and to widen the gap between groups. History has shown us: Encouraging this kind of culture inevitably leads to hate, conflict and war.

Worrying about these dynamics, the project "On second sight" was founded. We have the ambition to encourage individuals to read more than one page of a person's book before judging them. While we do not intend to change people's individual opinions, we want to open up their opinion-forming process. We want to showcase that a screaming boss can be insecure and vulnerable, a banker can be altruistic, and the silent kid at school may be a genius in her own language. We want people to put things into perspective; we want to make them consider where others come from.

We believe that when we reflect on our own opinion-forming process and try to make it a more inclusive and open approach, we can decrease in-group/out-group behaviors, and, with that, a lot of other negatives: Fewer stereotypes, less discrimination, less polarization. Sounds too good to be true?

There are in fact many obstacles when trying to motivate people to become more reflective and considered. So, when seeing it as a short-term project, this might even be too good to be true. Therefore, we envision two steps in fostering more reflective opinion forming.

First comes awareness –the awareness that sometimes we evaluate others on information that is not sufficient to form a considered opinion.

Second comes active work against these tendencies. We want to encourage people to actively work against and correct this natural tendency. We want us and others to become more open-minded about other people.

An ideal outcome of our project would be that people were persuaded to adopt a natural, unforced, openmindedness when they encounter other people. And that they reflect more before making quick judgments.

Our study concludes that it is possible and necessary to create more awareness about how we form our opinions. However, we found that our posters alone were not able to generate enough impact to change the viewers' patterns of forming opinions. At times, this made us wonder if it is actually possible to change these patterns. After all, they are evolutionary, and they do indeed fulfill a purpose in certain situations. 'We may simply be biologically predisposed to categorize people. It helps us to give structure to all those stimuli we encounter daily. Also, individual experiences and characters make impossible a wholly objective view on the world. A completely open-minded and absolute perspective on a person is simply impossible.

Nevertheless, we should still work on our tendency to fit people to patterns. It is without a doubt a difficult task, but it is an important one, too. History has shown us time and time again what happens when we oversimplify the world in polarized terms of good and bad. Us against the Romans, us against the British, us against the Germans. This messaging is easy and infectious, but we know now that it does not lead anywhere good. What, however, brings benefit to all of us is collaboration in a complex global society. And collaboration starts with openness. And it starts with you.

Let's start being more open towards other people, let's start reading more than just the first page. And if we are lucky, we may meet the next Van Gogh in the process.

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On second sight – A study on the encouragement of multi-perspective thinking

Abstract

When we identify as part of a group, we tend to feel more empathy and be more helpful towards its members. On the contrary, we increasingly alienate ourselves from individuals who do not belong to this group, which can aggravate social differences and may ultimately produce negative consequences, such as radicalization. We analyzed the background and causes of group polarization through a review of the social psychological literature on the in-group/out-group phenomenon and extracted possible ways to overcome related detrimental effects. We developed a visual campaign to promote multi-perspective thinking among observers and to counteract the processes of group polarization. We conducted an online survey to test whether our poster campaign can enhance reflection on ambiguous situations and the empathy towards individuals whom these affect. Our quantitative and qualitative analysis of the survey results did not confirm our hypotheses and revealed shortcomings of the visual campaign, which are discussed in the report.

Background

The in-group/out-group phenomenon is a widely known and researched phenomenon in social psychology. Whereas the *in-group* represents a social group an individual identifies with as a member, the *out-group* is defined by the opposite: it is the social group with which an individual does not identify (Aronson et al., 2014). Identification depends on a number of factors, such as similar attitudes, shared values and ideas (Aronson et al., 2014). It has been shown that individuals feel more empathy towards their in-group, a process which is referred to as the intergroup empathy bias (e.g., Cikara et al., 2014; Xu et al., 2009). This has further been related to the empathy-altruism hypothesis, which states that, the more empathy we feel towards a person, the more we will attempt to help them for altruistic reasons (Batson et al., 1988). Conversely, individuals have a tendency to disassociate themselves from members of an out-group (Sidanius & Pratto, 2001). These findings can be interpreted to mean that we feel more empathy towards our in-group and, accordingly, are more helpful towards its members. At the same time, we increasingly disengage socially from members that we associate with our out-group.

These processes can lead to *group polarization*, which describes the tendency of taking the interaction and discussion within in-groups to extreme levels. As a consequence, this can widen the social gap between groups (Abrams et al., 1990; Woodward, 1995). Further, group polarization is reinforced by the fact that individuals begin to compare themselves to others when identification with their in-group becomes salient. Hence, categorizations that differentiate between in-group and out-group are used which, in turn, exacerbate the social gap (as discussed in: Yardi & Boyd, 2010).

The identification with individuals or social groups similar to us is also rooted in the fact that it provides social and emotional support (Hurlbert et al., 2000). Nevertheless, these mechanisms can equally engender negative consequences, such as radicalization and hatred against out-groups, among others (Sunstein, 1999).

Motivation & Goal

In order to counteract these negative consequences of group polarization, our motivation was to promote the adoption of multiple perspectives based on reflective opinion-forming. Stemming from the concept of polarization and the possibly severe consequences on communities and individuals, we were interested in promoting what we call *multi-perspective thinking*. In this regard, we define multi-perspective thinking as the consideration of a variety of possible reasons, arguments, and perspectives, including those of an out-group, for instance, when evaluating a social situation or a person. We aimed to counteract the proverbial *judging a book from its cover* and to motivate people to consider several points of view prior to forming an opinion about other people, as we believe it is important to consider multiple perspectives before judging a person or a circumstance.

We targeted our goal by developing a visual campaign as an approach to promoting multi-perspective thinking among observers. It has been shown that online platforms, which primarily promote exposure to the in-group, create an environment that encourages the adoption of antagonistic strategies and prejudice towards out-groups (Santos et al., 2021a). In the context of reversing these

mechanisms in social media, Santos et al. (2021b) found that affiliations with out-group members led to opinion convergence and prevented group polarization and further disagreement. They argue that exposure to out-group opinions and contacts can moderate opinions and thus reduce group polarization. We transferred these findings to a less dynamic and primarily analog format, posters in the context of a visual campaign. We assumed that presenting ambiguous situations and providing multiple possible explanations for these concurrently may elicit similar results to those found by Santos et al. (2021b). We, thus, wanted to test whether a carefully designed visual poster campaign, which is aimed at encouraging people to consider multiple opinions and explanations (i.e., including out-group opinions) in the context of judging other individuals, can promote multi-perspective thinking. Hence, our research question was the following: *Can a visual campaign encourage people to consider different perspectives when forming an opinion about another person?*

In sum, it has been shown that the exposure to ideas of out-groups can counteract mechanisms and negative consequences of group polarization (Santos et al., 2021b). Our visual campaign was grounded in these findings and targeted the consideration of different perspectives when forming an opinion about another person. We, thus, hypothesized that:

Hypothesis 1. After seeing the poster, participants will find a higher number of possible explanations for the example situation.

Hypothesis 2. After seeing the poster, participants will be less certain about the explanations for the example situation.

Hypothesis 3. After seeing the poster, participants will feel more empathy towards the person in the example situation.

Methods

Visual campaign

To answer our research question, we first designed four posters as part of our visual campaign. These posters featured various fictional characters and described a specific behavior of each of these characters. We intended to portray every-day behaviors or situations, which offer several possible explanations, and could, hence, lead to premature judgments of the characters depicted. To counteract this and to motivate the adoption of multiple perspectives based on reflected opinion-forming, each poster also addressed the backgrounds of these characters and gave explanations for their behavior. Figure 1 shows the posters of our campaign.

The four posters of the visual campaign

Participants

In total, 143 participants filled out the survey. From the original sample, we excluded n = 71 participants. Of those participants, 64 were excluded because they did not complete some or all of the questions relevant to the analysis, either before or after exposure to the poster. Once this quality assurance filtering was finished the control and experimental group differed in size, such that seven participants were removed from the experimental group to ensure equal group sizes of both groups.

Among the participants whose answers we were able to use, the mean age was 37.09 years (*SD* = 15.06, range: 20-99 years). Of those 22 were women, 57 were men and the rest did not specify. 25 were students, 37 employees, 14 were freelancers/entrepreneurs, 2 were pensioners and 1 was unemployed, the rest did not specify. The survey was entirely in German and distributed to a German-speaking audience. The origins of the participants were not researched any further.

Online survey

The online survey was set up on the survey platform soscisurvey. The procedure can be divided into a pre-questionnaire (pre-exposition; Time point 1 (T1)), exposure, and a post-questionnaire (post-exposition; Time point 2 (T2)). Participants were split into two groups: the first group (experimental group) saw one of the four posters from our visual campaign during the exposure. The second group (control group) saw the plain portraits, but without any text, i.e., explanations about the situation and the character, during the exposure. This enabled us to compare the participants' responses before and after they had seen the actual poster or control portrait respectively.

At T1, participants were presented with an example situation ("Imagine you work in a medium-sized company. You know from the human resources department that you have a new colleague starting today. You meet him in the hallway and greet him in a friendly manner. He walks past you with his coffee cup without reacting.") and subsequently were asked to respond to several questions re-

garding this example situation. To measure how many possible explanations participants found for this situation we asked "What do you think led to this situation/behavior?" (open answer format). The number of responses, but not their content, was considered for the following analyses. In order to analyze this aspect in more detail, we also asked about participants' certainty in relation to this answer ("How certain are you with this assessment?" from 0 = *not at all certain* to 100 = *very certain*) and we asked "Who is to blame for the situation?" (open answer format). We then presented another example situation based on the previous one ("As soon as he passes you, you hear him swearing softly. He spilled his coffee on the floor."), and in relation to this, we measured the empathy participants felt towards the person in the example situation. We followed Cikara et al. (2014) and asked "How bad does this make you feel?" and "How good does this make you feel?" on a continuum from 0 = *not at all* to 100 = *very*. This block was repeated at T2 to measure whether there were any differences in the answer before and after the exposition.

In the following, for a more detailed evaluation of the data, participants' demographics as well as their personality and empathy traits, i.e., stable characteristics of a person, were measured. We assessed personality using the 10-Item Big Five Inventory (BFI-10) (Rammstedt, 2007) and measured trait empathy utilizing the Basic Empathy Scale in Adults (BES-A) (Carré et al., 2013).

In the last part of the survey, we asked participants questions related to the posters to be able to analyze our visual campaign and its effect on the viewers. The items used were the following: (1) "How much did you like the poster?" (continuum from 0 = *not at all* to 100 = *very much*), (2) "Would you change anything about the poster?" (Likert scale from 0 = *would change nothing* to 5 = *would change fundamentally*), (3) "What would you change about the poster?" (open question), (4) "Do you think the poster helped you to evaluate the example situations differently/newly?" (continuum from 0 = *not at all* to 100 = *very much*), (5) "Do you think you would notice the poster in everyday situations in public places (like on your way to work)?" (continuum from 0 = *not at all* to 100 = *very much*).

Data Analysis

The following describes the statistical methods used to evaluate the collected data, both quantitatively and qualitatively.

Quantitative Analysis

Statistical analyses were performed using R-Studio. First, participants were excluded as described in section "Participants." The analyses were preceded by descriptive analysis of the sample characteristics and study variables, which are represented in Table 1 and Table 2.

Variable	Experimental group		Control group		Full sample	
	M	SD	M	SD	M	SD
Number of explanations (T1)	2.13	1.09	2.38	1.22	2.09	1.26
Number of explanations (T2)	1.82	1.04	2.20	1.31	2.00	1.18
Confidence (T1)	70.08	25.28	69.75	28.10	69.37	27.23
Confidence (T2)	70.30	24.34	69.32	30.42	69.84	27.24
Empathy towards person (T1)	-4.95	39.78	-12.89	37.11	-8.86	38.54
Empathy towards person (T2)	-7.83	43.79	-15.33	36.76	-11.31	40.67

Table 1: Descriptive Statistics for Study Variables

Data management

We measured empathy as an outcome variable, i.e., the answers to the questions "*How bad does this make you feel?*" and "*How good does this make you feel?*", and empathy as a personality trait (using the BES-A). We summarized the empathy outcome variable by multiplying the responses to the item "*How bad does this make you feel?*" by -1 and then adding both items to obtain a combined score (from -100 to +100). Regarding empathy as a trait, we computed the average of all items of the BES-A scale, which

are each measured on a Likert-scale. Some of the questions are negated, their answers therefore needed to be inverted. We further measured the Big5 empathy traits, but only used Openness in the analysis, which was similarly normalized from the two questions measuring it on a Likert-scale. Boolean variables were created to indicate the belonging to the control or experimental group, and to account for which poster was shown.

The free text answers in the survey referring to the explanation of the situation and the culprit(s) were manually parsed, since the automatic counting of explanations did not include every case. The problems encountered were either technical (the participant separated items with a comma instead of a new line) or, more often, language such as "both" referring to two culprits, "I don't know"/"none" referring to zero culprits, "all reasons before, and further [...]", where the simple counting of words is not enough to determine the number of explanations and culprits the participant referred to.

Hypothesis-driven analyses

Analysis 1. We conducted a 2 x 2 repeated measures analysis of covariance (RM ANCOVA) to investigate whether participants found more possible explanations for a person's situation after seeing our poster (Hypothesis 1). Thus, the within-subjects factor Time Point (two levels: pre exposition/T1, post exposition/T2), the between-subjects factor Group (two levels: experimental group, control group) were included. The covariates included to control for confounds were gender as a between-subjects factor (two levels: female, male) and age because we only delimited the age of our participants to a small extent. We also included the liking of the posters, empathy (trait) and openness as covariates. The dependent variable was the number of explanations participants gave for the example situation.

Analysis 2. To test our second hypothesis, namely that after seeing our poster, participants will be less certain about the explanations they gave, we repeated analysis 1, but with a different dependent variable. We computed the RM ANCOVA with the certainty ratings as the dependent variable.

Analysis 3. To examine whether participants felt more empathetic towards the main character in the example situation after seeing our poster, we repeated analysis 1 with the dependent variable empathy (outcome).

Exploratory analyses
Since we did not find an interaction between Group and Time Point, we computed four new boolean variables to differentiate which of the 4 posters participants had seen (i.e., one boolean variable for each poster). We repeated all three analyses and included the four new variables as between-subjects factors to the analysis.

Qualitative Analysis
For the qualitative analysis, we examined the responses of participants from both groups to the open-ended survey questions ("*What do you think led to this situation?*" (Question 1) and "*Who is to blame for the situation?*" (Question 2)). We analyzed their responses for both questions separately. In the first step, we screened the answers in both groups for each question. One participant can give multiple answers, each of those counting separately. Based on the given answers, we defined different categories to which responses with similar content were assigned. Responses that are not clearly identifiable as such or are not clearly assignable to any of the established categories are counted under "not allocated." The second step was to count the number of responses affiliated with each category. This was done separately for the answers to both questions during the pre-questionnaire and the answers during the post-questionnaire.

The designation of the categories is chosen from the point of view of the questionnaire participant. In the situation, the participant takes on the role of the employee who is not greeted by his new colleague.

Table 3 provides an overview of the derived categories for Question 1, as well as some example responses to exemplify the assignment.

Category	Example Responses
justified in the colleague	
without bad intent	shy, fearful, introverted, nervous, excited, over strained, insecure, stressed, busy, focused, problems, worries, in though, unobservant
justified in the colleague with bad intent	disinterested, dislike, rude, arrogant, ignorant, bad upbringing, bad mood, bad day
caused by the situation	misunderstanding, language barrier, not noticed
justified in the colleague	disabilities, illness, psychological problems
company determined	bad company culture, bad onboarding process
neutral	nothing special, random
self-determined	my fault

Table 2: Categories with Example Responses to the Question "What do you think led to this situation?"

For Question 2, the derivation of the categories mostly corresponded to the given answers. The categories regarding whom participants assigned the blame to in the example situation were divided as follows: nobody, me, both of us, the colleague, the colleague's bad upbringing, the colleague's emotions, the overall situation, the corporate culture, the society, disability or illness, they do not know.

A similar procedure was chosen to analyze the answers on the question concerning the poster design ("Do you have any other comments about the poster or the experiment?"). Here, the open-ended answers were tagged with keywords depending on their contents. For example, answers like "Stripes on posters are too dominant" and "Stripes are distracting" both were categorized under the feedback tag "less stripes." To further categorize the feedback tags, they were then summarized into more general feedback buckets. For example, the bucket "Feedback on graphical

design" includes tags like "too colorful," "too dark," or "too many design elements."

Outcome and Discussion
Results
Quantitative Analysis
Hypothesis-driven analyses

Analysis 1. None of the factors or covariates were significant.

Analysis 2. A significant main effect for liking ("How much did you like the poster?": $F(1, 135) = 5.040$, $p = .026$, partial $\eta^2 = .04$, and trait empathy, $F(1, 135) = 9.853$, $p = .002$, partial $\eta^2 = 0.07$) was found. Certainty was significantly lower the more participants liked the poster they saw (SE = 0.098). Certainty was significantly higher the higher participants scored on trait empathy (SE = 5.425). None of the other factors or covariates were significant.

Analysis 3. We found a main effect for Group ($F(1, 133) = 7.796$, $p = .006$, partial $\eta^2 = .06$), liking ($F(1, 133) = 13.440$, $p = .000$, partial $\eta^2 = .09$), and age ($F(1, 133) = 4.058$, $p = .046$, partial $\eta^2 = .03$). Felt empathy towards the person in the example situation was significantly higher in the experimental group than in the control group (SE = 8.479). Felt empathy was significantly lower the more participants liked the poster they saw (SE = .131), and it was significantly lower the younger participants were (SE = .201).

Exploratory analyses
We conducted an exploratory analysis, different from our a-priori hypotheses. We postulate that, although no effect for the experimental group is found for any of the three hypotheses, there might be an effect of a specific poster being shown, since the four display a different message. After conducting a further analysis of covariance, no such effect was significant.

Qualitative Analysis
The following sections provide an overview of the qualitative analysis of the data collected. This includes, firstly, the participants' responses to open-ended Questions 1 ("What do you think led to this situation?") and 2 ("Who is to blame for the situation?") of the survey. Furthermore, the feedback of the participants regarding the poster design is discussed in more detail.

Response to the open-ended survey questions
The following presents the number of responses affiliated with each derived category for the open-ended survey questions. The distribution of these data in absolute numbers and percentages for the times T1 and T2 and between the experimental group and the control group is shown in Table 4 for Question 1 and Table 5 for Question 2, respectively.

Regarding Question 1, 47% of the responses of the control group at time T1 answered that the new colleague was the culprit in the example situation, without assuming bad intentions on his part. Bad intentions were assumed by 26.8% of the responses. 6 % of the answers referred to a disability or illness as a possible explanation of the new colleague. In the experimental group, 41.9% of the responses did not refer to bad intentions, but 31.6% of the responses suggested negative intentions. An existing disability or illness was mentioned in only 1.5% of the responses. These observations indicate differences between the two groups.

After the exposure (at T2), the percentage of responses that do not indicate bad intention behind the new colleague's behavior is similar for both groups when compared to T1. In contrast, responses citing a bad intention of the new colleague decreased by 15.2% in the experimental group and by 16% in the control group. The largest increase (of 613.3%) was found in the experimental group for the category that includes responses regarding a possible disability or illness of the colleague. In the control group the increase was 30%. The differences in the other categories were in the low single digits.

Category	Experimental group				Control group			
	T1		T2		T1		T2	
	n	%	n	%	n	%	n	%
justified in the person without bad intent	57	41.9	46	41.1	70	47.0	59	45.7
justified in the person with bad intent	43	31.6	30	26.8	40	26.8	29	22.5
justified in the person	2	1.5	12	10.7	9	6.0	10	7.8
caused by the situation	13	9.6	10	8.9	14	9.4	10	7.8
company determined	10	7.4	7	6.3	13	8.7	14	10.9
neutral	4	2.9	3	2.7	0	0	0	0
self-determined	2	1.5	1	0.9	1	0.7	1	0.8
not allocated	5	3.7	3	2.7	2	1.3	6	4.7

Note. Experimental group (T1: n = 136, T2: n = 112). Control group (T1: n = 149, T2: n = 129). The percentages refer to the absolute sum of given answers at the respective time point in the respective group, and not on the number of participants. For example, of all the answers given in the experimental group at T1, 41.9% can be assigned to the category which contains all responses where the observer assumes that there is no bad intent behind the behavior of the new colleague.

Table 3: Frequency of responses to the question "What do you think led to this situation?"

Category	Experimental group				Control group			
	T1		T2		T1		T2	
	n	%	n	%	n	%	n	%
nobody	24	26.7	26	32.9	20	19.4	19	22.9
me	5	5.6	3	3.8	7	6.8	4	4.8
both of us	1	1.1	1	1.3	4	3.9	2	2.4
colleague	32	35.6	24	30.4	35	34.0	27	32.5
colleague's bad upbringing	2	2.2	2	2.5	2	1.9	2	2.4
colleague's emotions	5	5.6	0	0	2	1.9	2	2.4
overall situation	3	3.3	4	5.1	4	3.9	4	4,8
company	12	13.3	9	11.4	19	18.4	15	18.1
society	2	2.2	4	5.1	1	1.0	1	1.2
disability/ illness	1	1.1	2	2.5	0	0	1	1.2
I do not know	3	3.3	4	5.1	5	4.9	3	3.6
not allocated	0	0	0	0	4	3.9	3	3.6

Note. Experimental group (T1: n = 90, T2: n = 79). Control group (T1: n = 103, T2: n = 83). The percentages refer to the absolute sum of given answers at the respective time point in the respective group, and not on the number of participants.

Table 4: Frequency of responses to the question "Who is to blame for the situation?"

With relation to Question 2, in both groups, the majority of answers referred to the colleague as being at fault, with a majority of 35.6% in the experimental group and 34% in the control group at T1. The second-largest part of the answers saw the blame in nobody (26.7% in the experimental group and 19.4% in the control group). The company was indicated as responsible in 13.3% of the answers in the experimental group and 18.4% of the answers in the control group.

At T2, the number of responses that saw no one to blame increased by 23.2% in the experimental group and 18% in the control group. The amount of responses that saw the blame on the new colleague decreased by 14.6% in the experimental group and by 4.4% in the control group. The remaining changes were marginal.

Feedback regarding the poster design
Participants were asked for feedback on the posters ("What would you change about the poster and why?"). The following results only include feedback from the experimental group as they saw the actual posters.

31% of participants stated that they suggest minor changes to the poster, while 9% asked for a fundamentally new poster design. 26% of participants preferred almost (17%) or totally (9%) the current poster design. 20% of participants were indecisive and another 13% did not provide answers to this question.

Looking specifically at critical comments, feedback can be categorized as follows:
1) Objections to the design of the poster;
2) Objections to its functioning mechanism;
3) Criticism regarding the understandability of the poster and its message.

Out of these categories, the graphical design of the poster was most frequently mentioned. Participants would like to see a less busy layout with a smaller number of elements. Specifically, they envision a layout with fewer, or without, stripes. The text was partly perceived as too small or as hard to read. Several participants suggest changing the color scheme to improve readability of the text. The suggestions concerning the colors of the poster were diverse and sometimes contradictory. While some (n = 3) participants found the color scheme to be too dark, others (n = 2) found the text to be too colorful. Additionally, one participant pointed out that it was hard to read the text because of its placement between the stripes and the positioning of the line breaks.

Next to the graphical design of the poster, some (n = 4) participants mentioned that they were unsatisfied with the functioning mechanism of the poster. In particular, they did not like to be influenced (or manipulated) in their opinion by our posters. Furthermore, the emotional aspect of the posters was pointed out by three participants. To them, the concerns in our posters felt artificially created, the emotional aspect was generally not appealing, or an unwanted feeling of guilt arose from it.

Lastly, the understandability of the posters was mentioned as part of the critical feedback. Two participants of the survey would like to see some explanation of the topics presented on the posters. Another participant suggested fostering ease of understanding by simplifying the presented topics, as opposed to just explaining them.

Discussion
By designing a visual campaign consisting of four posters, we aimed to counteract the negative consequences – namely, radicalization and hatred – of group polarization (Sunstein, 1999). Based on previous findings by Santos et al. (2021b) in the realm of social media, we assumed that our posters would encourage observers to consider multiple opinions and explanations when judging other individuals, and, hence, promote multi-perspective thinking. We designed an online survey on the basis of which we compared answers of participants before seeing our poster and after seeing them.

Quantitative Analysis

Contrary to our three hypotheses, we did not find any differences in the number of explanations, nor in certainty, nor in the empathy participants felt towards the person in the example situation after participants saw our posters (outcome empathy). We refrain from interpreting the effects of our analyses as the effect sizes were small.

Quantitative Analysis

Comparing the responses of both groups to Question 1 at T1, it becomes evident that already at the baseline both groups differed. The control group perceived the new colleague in a better light than the experimental group and saw the reason for the new colleague's behavior as external or unintentional. In contrast, the experimental group showed a more negative attitude towards the new colleague at the beginning (at T1). The assumption that the new colleague acted out of bad intentions decreased in both groups as a result of the exposure. A strong change could be noted with regard to a possible disability or illness, especially in the experimental group. Similar changes from T1 to T2 were observed for Question 2. This could be indicative of the effectiveness of our poster campaign. However, this assumption is not supported by the results of the quantitative analysis. Therefore, no clear conclusions can be drawn regarding the effectiveness of our campaign.

Interestingly, in absolute numbers, there were more responses to Question 1 for both groups at both time points in which the blame was seen to lie with the observer him/herself than in Question 1. We may have found these differences as a consequence of the wording of Questions 1 and 2.

Furthermore, the open-ended questions in the survey showed that 40% of participants had objections to the design of the posters (31% minor and 9% major objections). An unattractive poster design can cause the posters to be less effective when the poster campaign is displayed in public places. An attractive poster layout is more easily noticed and can hold viewers' attention longer. This, in turn, could affect the effectiveness of the poster.

Limitations

This study was subject to limitations, which we will highlight briefly. The control group in the survey was presented with our posters, the only difference was that they saw the posters without text. Consequently, they still saw the poster, including the graphical elements and the photograph in the background. Hence, we cannot say to what extent the experimental condition and the effect of our poster was different in both groups. Alternatively, the control group could have answered the survey without seeing any posters.

Another methodological limitation of our study stems from the example situation. We cannot assume that the new colleague was interpreted as belonging to the out-group because he fictitiously belonged to the same company. Further studies could examine the effectiveness of our posters using other situations that better distinguish between in- and out-group. In addition, participants viewed the posters on a screen. We could not control how large this was and how long participants viewed the posters. Furthermore, in a use case, these posters would not be presented on a screen, but primarily in analog form (e.g., on train platforms, streets, etc.), which limits the external validity of our study.

The limited effectiveness of our posters may be explained by the poster design. As pointed out in section "Feedback regarding the poster design," the layout and design of the poster was not appealing to all participants. With a layout that is perceived as too crowded or a color scheme that is perceived as too dark or too sad, participants may have already had a negative attitude towards the poster before even evaluating its meaning.

Ultimately, we committed errors in the procedure because we did not determine the final sample size a priori. A sample size calculation using G*Power 3.1 (G*Power 3.1. (Faul et al., 2007)) a posteriori showed that a sample size of N = 210 would have been necessary to achieve a mean effect size according to Cohen (2009).

Summary and Future Goals

Aiming to achieve multi-perspective thinking and consequently degrade the negative effects of polarization, we studied the effect of a visual campaign on considering multiple points of view before forming judgements about people. We developed a visual campaign consisting of four posters, the effectiveness of which we tested using an online study. Our results did not show that the posters had an effect on the number of possible explanations participants found for a person's situation or behavior. We further did not find that the exposure to our posters influenced certainty or empathy towards this person.

Future work should especially consider the methodological limitations of our study and test the posters on a larger sample, optimally in a natural setting that ensures external validity. The feedback regarding the poster's design should be reevaluated and posters should correspondingly be adjusted. This reevaluation is important as unstudied adjustments could engender bias, affecting thus the message meant to be conveyed through the campaign. The second aspect would be restudying the same factors considered above, but with a larger sample. This is essential to examine the effects of design adjustments and uncover potential relationships. Should the campaign prove effective in this instance, it could be launched on TUM's campus and in public areas across Germany to validate it in a representative environment and to eventually achieve the campaign's main goal: promoting multi-perspective thinking.

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Self-reflection

"If you want to go fast, go alone. If you want to go together." And together we went. Right from the outset, a natural sense of connection characterized our team, even when team members had to step back from their commitment to TUMJA due to personal circumstances. Most teams can't do without a clear leader, yet our team thrived despite or maybe because of the absence of such a leader. Without a doubt, this couldn't have been possible without the strong support and valuable guidance by our esteemed supervisors Prof. Dr. Martin Werner and Prof. Dr. Elisa Resconi as well as our dedicated tutors Panagiotis Christou and Samuel Valenzuela.

We knew that the right calibration for the direction of our project at the start of this interdisciplinary adventure would help us in finding a purpose that each of us could support avidly and wholeheartedly. Hence, we collectively decided to take our time to thoroughly incubate, revise and refine our project idea. Beautifully creative brainstorming sessions sparked a diverse set of great ideas, which all shared a common tagline of contributing towards and improving culture through increased empathy. Ideas ranged from overcoming the cultural barriers that hinder debate between political groups through gamified consensus-building in the form of a new type of social network designed to overcome polarization, to panel discussions with everyday people sharing unique insights into their life as a means to gain perspective.

Against the backdrop of increased (perceived) global polarization and its manifestation in unprecedented political events such as the United States Capitol attack, we decided to take action by fostering a culture of stronger mutual understanding, empathy and healthy diversity of opinions.

Frankly speaking, pinning down our idea and accurately framing it for everyone to understand proved to be a bit of a challenge initially. That's only one of the occasions where the immensely valuable guidance by our supervisors and tutors helped us bring things back on track.

The diversity within our team proved especially valuable when it came to taking things to the scientific level, as only some of us were familiar with concepts like in- or out-group bias or homophily to name a few. Through our research, we increasingly came closer to uncovering the underlying challenge at hand that, in turn, helped us brainstorm and refine ideas on how to measure as well as mitigate it.

Again, none of this was a linear process but the result of iterative ideation, which was one of the aspects everyone in our team benefited from and enjoyed a great deal. The free, creative and, most importantly, constructive exchange of ideas proved to be a trademark of our team throughout the whole project. Nevertheless, we had to occasionally take a step back and gain a perspective on our ideas from people outside the team. However, our team rose to the occasion and delivered when we had to, which proves the dedication of everyone involved. Whether it's preparing the visuals or crafting a scientific survey while being pressed for time, we managed to pull it off collectively with every team member carrying their weight after all. This is especially fascinating given that most, if not all, team members either moved to another city or even another country, started a new degree or took a new job in the process. Nevertheless, each team member contributed through their unique and strong skill-set, ranging from analytical thinking, photo and video editing, scientific analysis, linguistic talent, strong communication and effective organization.

In retrospect, we all gladly look back at a journey of growth, connection, learning, newly found friendship, and, above all, fun. We wouldn't have wanted to miss it, and for that we are all immensely grateful. Thank you.

POSTER 1:

We were able to converge on and define our project idea after reflecting on different ideas together as a team. Through research, we found out that polarization was a consequence of strong in-group and out-group thinking. Given the difference in empathy towards people in either one's in-group or out-group, people tend to increasingly disassociate themselves from people in their out-group, which leads to echoing and potentially radicalizing effects with less and less exposure to diverse ideas. Hence, we decided to break through this vicious cycle by conducting a visual campaign that encourages people to reflect on opinions other than their own in order to promote a healthy plurality of opinions and reduce radicalization. Our project structure plan was framed by internally and externally set deadlines, e.g. for drafting visuals or formulating a questionnaire. In addition, intermediate evaluations and the Future Lab represented other major milestones on our journey to research the question of whether a campaign can motivate people to reflect on their opinions and consider perspectives outside their in-group. ◼

On a second sight
A study on the encouragement of multi-perspective thinking

WHAT HAPPENED SO FAR?

During our initial literature search, we found that individuals feel less empathy towards people they identify less with (people that belong to a so-called out-group as opposed to an in-group).[2,4,5] This can lead to hatred against these people and widen the social gap between groups.[1,3,6,7] Based on this, we developed two first poster drafts which we believed encouraged observers to consider different perspectives when forming an opinion about another person. We then evaluated these drafts in a qualitative online survey. We took the results of this survey as a guideline to design a second draft which we will evaluate in a second, more elaborate and mainly quantitative survey.

OUR FIRST RESULTS

We found that the design in which we leveraged text to convey a story was the most remarkable and self-explaining to the participants of our first survey. We also concluded from the results that we should not target a prominent, political figure because of the difficulty to project a neutral political stance. Hence, we decided to focus on a variety of people in the German society whose cultural and religious background or work circumstances often lead to hasty judgments.

TeamCulture

RESEARCH QUESTION

Can a poster campaign encourage people to consider different perspectives when forming an opinion about another person?

OCTOBER 2021

MEMBERS: Musa A., Mohammad Hashem, Lisa Henicz, Adrian Löwenberg Casas, Annabel Matz, Eva-Madeleine Schmidt, Josephine van Delden, Niclas Weddigen
TUTORS: Panagiotis Christou, Samuel Valenzuela
SUPERVISORS: Prof. Dr. Elisa Resconi, Prof. Dr. Martin Werner

POSTER 2:

"In what way can we elicit a more nuanced perspective from people?" was a question we asked ourselves in order to determine the actions we could take to mitigate the problem at hand. The goal was to increase empathy for people outside one's in-group in order to avoid hatred and close societal rifts along polarized stances. We knew we had to tell a story. We knew we had to tell it in a succinct yet impactful manner. Given the omnipresent battle for attention, our campaign had to convey a strong message to stand out and grab attention while being as concise possible. While we saw that text is a strong medium to convey one's story, it needed a strong and noticeable visual component to it, which we realized in the form of posters. In order to find out whether our poster campaign can encourage people to consider different perspectives when forming an opinion on another person, we included a qualitative survey as part of our online poster campaign. As a result, we saw that a story in text form paired with strong visuals conveyed a message, albeit and inadvertently a different one to different people. Since the prominent person we included in our posters was charged with a range of public associations, we decided to level the field by moving to include largely unknown, everyday people as part of our posters. ◾

POSTER 3:

The feedback we got showed us that we were headed in the right direction. Step by step, we came closer to finding the right design and structure of our posters. Thanks to TUMJA, we were assisted by a professional graphic designer who helped us bring the posters to a more professional level by ensuring consistency and quality in an iterative approach. Given that our poster campaign is conducted in German and in the German context, we decided to include people who reflect that and share a story that's relevant and recognizable for the target audience. Moreover, valuable feedback by our supervisors helped us in selecting people for our posters who were closer and more representative as a cross section of society. In addition, we moved beyond qualitative analysis by including a quantitative survey component in order to capture more impressions and data. The online survey with updated posters and quantitative questions aimed at a sample size of a minimum of 60 different participants. Once we could gain more information and know whether our posters achieve the desired effect, we provisionally planned to run an offline campaign at campus and other locations in Munich on an experimental basis.

POSTER 4

Project Report **CreaThesis**

Complex scientific work has a growing impact on daily life, and it is very important to communicate it in an accessible way. Yet, science communication is a skill that is often overlooked at universities. Team CreaThesis dedicated itself to question the current science communication between science and the public and aimed to improve the scientific communication skills of students via the use of art. Derived from studies which examined the impact of art onto the human brain and our perception, the idea was that creativity and art may provide additional support for a good research idea, innovative methods, and sound and understandable science communication.

CreaThesis

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Preface by the Supervisors

Prof. Dr. Ernst W. Mayr and Prof. Dr.-Ing. Rolf Moeckel

There is the widely held perception that scientists (more or less in all fields, and in the fundamental or natural sciences, in particular) do not communicate their work and their results in a commonly understandable language to the general society (which, quite often, is actually providing the financial support for this work). It should be clear that, given its complexity, much of the scientific discourse necessarily relates to intricate details, uses very special concepts, knowledge and language and takes place within rather small (scientific or related) communities. Obviously, such scientific communication must be precise, un-ambiguous and "technical" (actually, a fundamental postulate

and tenet for modern science). However, there are also some authors who communicate their findings poorly, with unnecessary jargon, getting lost in details and in needlessly convoluted language. While the complexity of science requires precise language, there are also very good reasons to search for ways to improve the communication of science, both between scientists and to a more general audience.

During the Middle Ages, there was a language issue. Science was available in Greek, Latin, or even Arabic, and most people in Europe did not know any of these languages or could not read them, or simply lacked the required background knowledge. In contrast to science, religion was communicated through the arts, including painting, sculpture, music and architecture. Art has been accessible in one way or the other to almost everybody, and this since very long times. It comes in many manifestations, a large number very independent of language, and (more or less) a communication channel open for most.

Thus, it is an intriguing idea to use the additional channels provided by the expression of art to communicate (impressions of) scientific work to a larger or different audience, less restricted by language or previous knowledge. A team of eight outstanding TUM students (all selected members of the TUM Junge Akademie program) established the CreaThesis project, whose goal it is to provide a framework and internet portal for all TUM students to make available to the general public more "artful" representations (possibly using alternative media) of their thesis work. The first examples implemented by the team suggest that art can open up to a much broader audience fields of research formerly accessible to a small research community only. This is scientific communication at its best! ■
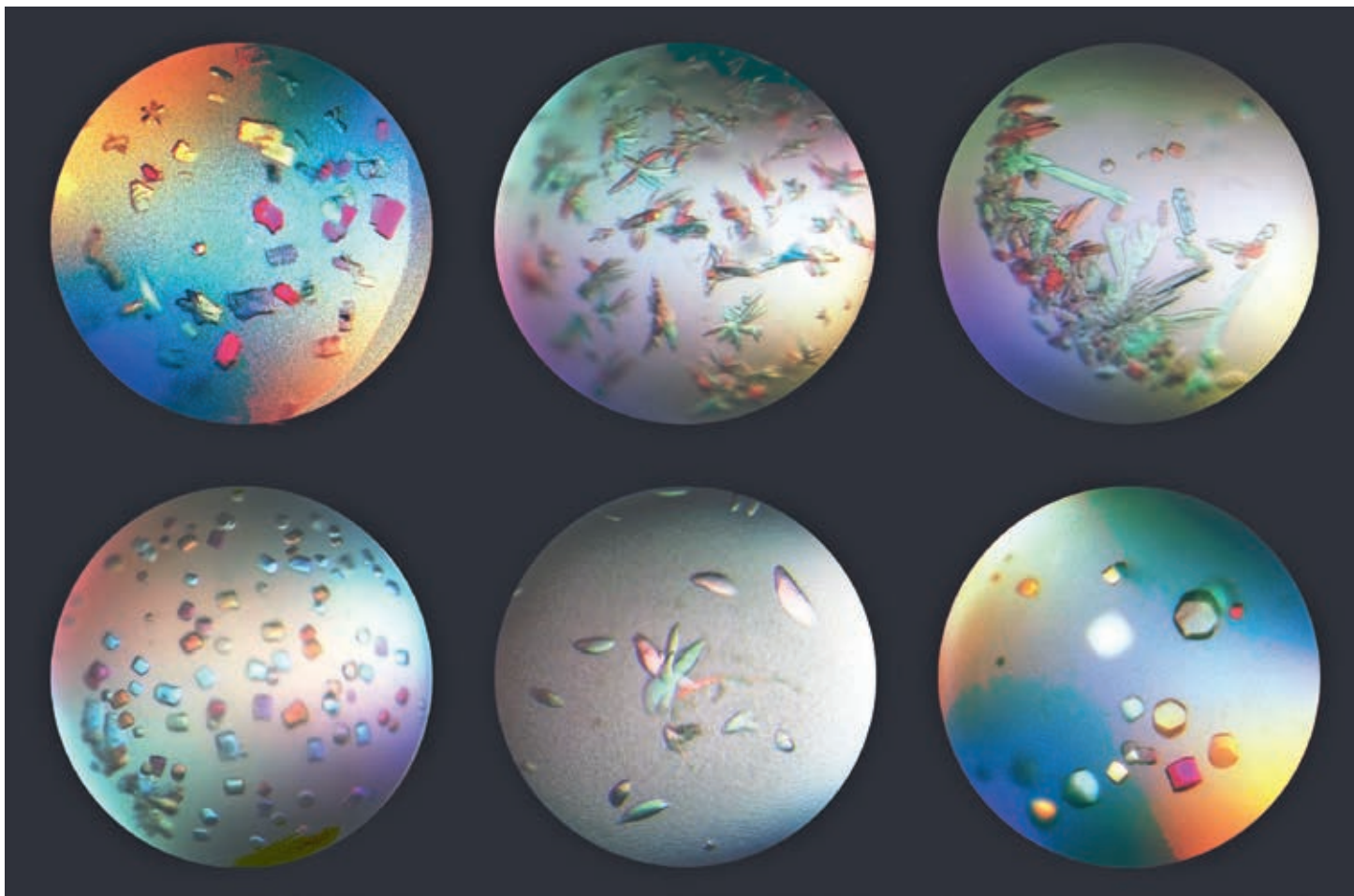
A look into the crystals – The production of protein crystals for structure prediction.
CreaThesis of Theresa Franz

Science and Art do not fit together

By: Andrea Schittenhelm and Nico Michel, representing Team CreaThesis, Class 2021

Scientific communication is mostly done in one's own subject area. Therefore, scientists usually do not have to explain fundamental issues as simply as possible to reach the public with their findings. This situation has changed significantly during the last two years. In comparison to previous decades, the pandemic showed us that it is now more important than ever to communicate the most relevant research findings to the public and to explain their backgrounds.

The question is: does scientific communication have to change in order to reach the public with the most relevant scientific results?
Scientific articles typically appear as written text with few illustrations. They are rather inflexible because of their standardized structure for each and every research field – from architecture to zoology. A written text in an objective (if that is possible), flat, unemotional style. It is just meant to convey data. It is meant to convey knowledge. It is meant to convey theories. The most important content is provided as simply as possible. No rehearsal, no rhyme. Seldom will you find suspense until the most important result is revealed. Do you still remember the content of a poem you learned at school? A song you sing by heart? It is easier to remember things that include some of these properties. However, reaching the public means to convey advice and information in a clear, reassuring, understandable and memorable manner. Notably, remembering information often means to have a story, emotional bonding, tension, or rhythm. What if we could write scientific content in blank verse, or construct information as songs are composed? Introducing new information in *strophes; bridging the strophe* with the main parts and hook the reader's attention.

If we answer this question with yes, how does the manner of communication have to change?
Maybe we should include a style of communication that has all these components naturally – like art.

Art can be playful, emotional, shocking, soothing, a picture, a painting, a text, a composition, a sculpture; 2D, 3D, 4D – in short: it could be a better communicator. A more flexible tool. Adapted for everything - from architecture to zoology. Especially when it comes to science communication for the public. However, it is neither a general fix, a one-size-fits-all solution, nor is it conventional for science communication – yet.

To answer some of our many questions regarding this topic, we asked Professor Felix Mayer for his impressions regarding interactions between technical topics and art. The interview was carried out in German and later translated into English. We apologize for any loss of linguistic quality. For the original, see below.

CreaThesis: The founding motto of TUM is: "Scientiis et artibus" – "To the sciences and the arts" - Do you think that science and art are compatible?
Prof. Mayer: It is very welcome that the students of the TUM: Junge Akademie reflect on the concepts of "science" and "art." Thinking about what "science" means, how it should be pursued, and what role "art" plays in the life of every human being, is not only necessary, but should be thoroughly reflected upon by all members of the university, so that "Scientiis et artibus" is not just a somewhat sooty inscription on the facade of our beloved educational institution in Gabelsbergerstraße, or a slogan to be used in celebratory speeches.
Are science and art compatible? It is to misjudge the unity of the world if one considers science and art to be fundamentally different things that have nothing to do with one another or, at best, meet in design for product sales or as tools for science communication. We are always dealing with the world as a whole, whether we are aware of it or not.
It almost seems to me that in the words "Scientiis et artibus" the connecting "et" is the most important of the three words.

CreaThesis: In your opinion: what is the biggest similarity between science and art?
Prof. Mayer: Science and art are very human. That is also, but not only, meant as a compliment.

CreaThesis: In your opinion: what is the biggest difference between science and art?

Prof. Mayer: The formula E=mc^2 would probably have been written down also without Einstein, only a little later, and the double helix structure of the DNA would have also become scientific standard without Watson and Crick.

Of course, it is important when something happens, and the triumph of human thinking should not be diminished. But Frida Kahlo's paintings could only have been painted by Frida Kahlo, and by no one else; Marie A. could only be remembered by poor B.B.; and the choruses in "Idomeneo" could only have been composed by Mozart.

This is also connected with the fact that scientific striving and research is actually always considered under the reservation of provisionality. Even Euclidean geometry was supplemented by a later colleague with the strange name non-Euclid. Following generations will correct mistakes and interpret the world differently, they might possibly also forget correct and important things, as it is true for us in our time now.

But the paintings in the Lascaux caves, Beethoven's Ninth Symphony, or a recital by Jessye Norman are not provisional until something less flawed is developed or thought. That is a huge difference.

CreaThesis: How do you perceive the interaction between science and art?

Prof. Mayer: At this point, it seems to me that we have to specify *which* science and *which* art you actually mean. And *where*. In *which* faculty or school, in which museum, concert hall or streaming channel. And at what *time*. Now, instantaneously in 2022, or in the last 200 or 500 years. Operated by *which* scientists, scholars, and artists.

Without waiting for my follow-up questions to be answered, I answer in a very general and inadequate way, that at the moment – except in very technical art forms such as film or game development or, as already mentioned above, product design for the better salability of products – to me, it does not seem to be a particularly intensive interaction between "the" sciences and "the" arts. But it is very likely that I am wrong.

Prof. Felix Mayer Honorary Professor for Music at TUM since 2017, Department of Educational Sciences. He received a musical education in Germany and toured with orchestras throughout Europe. In 2012, he founded the TUM Choir and cooperated with the Münchner Philharmoniker. He teaches at the Carl von Linde-Akademie and is also a supervisor at the TUM: Junge Akademie.

CreaThesis: How do you combine science and art in your daily work?

Prof. Mayer: I cannot and do not want to separate science and art – and perhaps I cannot even combine them. I refer to my final sentence of the first question: It almost seems to me that in the words "Scientiis et artibus" the connecting "et" is the most important of the three words.

CreaThesis: Do you see the possibility that science may reach more people via a more artful presentation?

Prof. Mayer: Not only do I see this possibility, it also seems to me to be the only promising way forward.

But this insight is not new; Friedrich Schiller already wrote:

"From the mysteries of science, taste (beauty, art) leads knowledge out under the open sky of common sense and transforms the property of schools into a common property of all human society. "

But it does not seem superfluous to me to point out that here, too, we have to ask ourselves which science is actually meant. It would be dangerous if we were to regard "science" per se as something basic and absolutely worth promoting. It is too human for that. Of course, this also applies to "art."

Art, with its powerful means, can also give prestige, respect, and validity to products of an overgrown science. And since "science" primarily provides provisional results until they are refuted, scientific and pseudo-scientific achievements – I am thinking here of alchemy or astrology, for example – can acquire a false permanence through artistic means and cement prejudices longer than necessary.

CreaThesis: How do you evaluate the chances for art to be more involved in science communication in the future?

Prof. Mayer: If I get up in the morning on the right leg, I am hopeful and see opportunities; if I get up on the wrong leg, I am pessimistic.

But it is up to all of you, the young scientists, whether there is a chance for art to be more involved in science communication in the future. But as I repeat your question and write it down again, I have to confess that I don't like this formulation at all. I think it would be more of an opportunity for science communication, not for art, if art were to give science communication a little bit of a hand.

And since future developments are up to you, it's your job to expand and train your art appreciation and cultural literacy every day. ■

CreaThesis: Das Gründungsmotto der TUM ist »Scientiis et artibus« – »den Wissenschaften und den Künsten« – Halten Sie persönlich Wissenschaft und Kunst für vereinbar?

Prof. Mayer: Es ist sehr begrüßenswert, dass die Studierenden der Jungen Akademie über die Begriffe »Wissenschaft« und »Kunst« nachdenken. Das Nachdenken darüber, was »Wissenschaft« bedeutet und wie sie betrieben werden sollte und welche Rolle die »Kunst« im Leben jedes Menschen spielt, ist nicht nur notwendig, sondern sollte gründlich von allen Mitgliedern der Universität reflektiert werden, so dass «Scientiis et artibus« nicht nur eine etwas verrußte Inschrift an der Fassade unserer geliebten Bildungseinrichtung in der Gabelsbergerstraße ist, oder ein Slogan, der in Festreden zur Verwendung kommt.

Sind Wissenschaft und Kunst vereinbar? Es heißt, die Einheit der Welt zu verkennen, wenn man Wissenschaft und Kunst für grundverschiedene Dinge hält, die nichts miteinander zu schaffen hätten oder sich bestenfalls im Design zum Produktverkauf oder als Hilfsmittel zur Wissenschaftskommunikation träfen. Wir haben es immer mit dem Weltganzen zu tun, ob uns das nun bewusst ist oder nicht.

Beinahe will mir scheinen, dass bei den Worten »Scientiis et artibus« das verbindende »et« das Wichtigste der drei Wörter sei.

CreaThesis: Was ist Ihrer Meinung nach die größte Gemeinsamkeit zwischen Wissenschaft und Kunst?

Prof. Mayer: Wissenschaft und Kunst sind sehr menschlich. Das ist auch, aber nicht nur, als Kompliment gemeint.

CreaThesis: Was ist Ihrer Meinung nach der größte Unterschied zwischen Wissenschaft und Kunst?

Prof. Mayer: Die Formel E=mc^2 wäre wohl auch ohne Einstein, nur etwas später, niedergeschrieben worden, die Doppelhelixstruktur der DNS wäre auch ohne Watson und Crick wissenschaftlicher Standard geworden. Natürlich ist es von Bedeutung, wann etwas geschieht, und der Triumph menschlichen Denkens soll nicht geschmälert werden.

Aber die Bilder Frida Kahlos konnten nur von Frida Kahlo gemalt werden, von niemandem sonst, an Marie A. konnte sich nur der arme B.B. erinnern und die Chöre im »Idomeneo« konnte nur Mozart komponieren.

Damit hängt auch zusammen, dass wissenschaftliches Streben und Forschen doch eigentlich immer unter dem Vorbehalt der Vorläufigkeit steht. Selbst die euklidische Geometrie wurde durch einen späteren Kollegen mit dem seltsamen Namen Nicht-Euklid ergänzt. Nachfolgende Generationen werden Fehler korrigieren und die Welt anders deuten, möglicherweise werden sie auch Richtiges und Wichtiges vergessen, so wie das für uns in unserer Zeit auch gilt.

Aber die Bilder in der Höhle von Lascaux, die Neunte Sinfonie Beethovens oder ein Liederabend von Jessye Norman sind nicht vorläufig, bis etwas weniger Fehlerhaftes entwickelt oder gedacht wird.

Das ist ein gewaltiger Unterschied.

CreaThesis: Wie erleben Sie das Zusammenwirken von Wissenschaft und Kunst?

Prof. Mayer: An diesem Punkt angelangt, scheint mir die Nachfragen überfällig zu sein, *welche* Wissenschaft und *welche* Kunst Sie eigentlich meinen? Und *wo*? In *welcher* Fakultät oder School, in *welchem* Museum, Konzertsaal oder Streaming Kanal? Und in *welcher Zeit*? Jetzt, augenblicklich im Jahr 2022 oder in den letzten 200 oder 500 Jahren? Betrieben von *welchen* Wissenschaftlerinnen und Wissenschaftlern, Künstlern und Künstlerinnen? Ohne die Beantwortung meiner Nachfragen abzuwarten, antworte ich ganz allgemein und unzureichend, dass mir derzeit – außer in sehr technischen Kunstformen wie dem Film oder dem Game Development oder, wie oben schon erwähnt, dem Produktdesign zur besseren Verkäuflichkeit von Produkten – kein besonders intensives Zusammenwirken zwischen »der« Wissenschaft und »der« Kunst besteht. Aber es ist sehr wahrscheinlich, dass ich mich täusche.

CreaThesis: Wie kombinieren Sie Wissenschaft und Kunst in Ihrer täglichen Arbeit?

Prof. Mayer: Wissenschaft und Kunst kann und will ich nicht trennen und vielleicht kann ich sie noch nicht mal kombinieren. Ich verweise auf meinen Schlusssatz zu Frage 1: Beinahe will mir scheinen, dass bei den Worten »Scientiis et artibus« das verbindende »et« das Wichtigste der drei Wörter sei.

CreaThesis: Sehen Sie eine Möglichkeit, dass Wissenschaft durch eine künstlerische Darstellung mehr Personen erreicht?

Prof. Mayer: Diese Möglichkeit sehe ich nicht nur, es scheint mir auch der einzig erfolgversprechende Weg zu sein. Neu ist diese Erkenntnis aber nicht, schon Friedrich Schiller schrieb:

»Aus den Mysterien der Wissenschaft führt der Geschmack (Schönheit, Kunst) die Erkenntniß unter den offenen Himmel des Gemeinsinns heraus, und verwandelt das Eigenthum der Schulen in ein Gemeingut der ganzen menschlichen Gesellschaft.«

Aber mir scheint der Hinweis nicht überflüssig, dass wir uns auch hier die Frage stellen müssen, welche Wissenschaft eigentlich gemeint ist. Gefährlich wäre es, wir würden »Wissenschaft« per se als etwas Grundgutes und unbedingt Fördernswertes betrachten. Dafür ist sie zu menschlich. Das gilt selbstverständlich auch für »die Kunst«.

Die Kunst mit ihren mächtigen Mitteln kann nämlich auch Produkten einer verwilderten Wissenschaft Ansehen, Respekt und Geltung verschaffen. Und da »Wissenschaft« vor allem vorläufige Ergebnisse bis zu deren Widerlegung liefert, können durch künstlerische Mittel wissenschaftliche und pseudowissenschaftliche Errungenschaften – ich denke hier beispielsweise an die Alchemie oder die Astrologie – eine falsche Dauerhaftigkeit erlangen und Vorurteile länger als notwendig zementieren.

CreaThesis: Wie schätzen sie die Chancen für die Kunst ein, in Zukunft mehr in die Wissenschaftskommunikation involviert zu sein?

Prof. Mayer: Wenn ich morgens mit dem richtigen Bein aufstehe, sehe ich hoffnungsfroh Chancen, wenn ich mit dem falschen Bein aufstehe, bin ich pessimistisch.

Es liegt aber vor allen an Ihnen, den jungen Wissenschaftlerinnen und Wissenschaftlern, ob eine Chance für die Kunst besteht, in Zukunft mehr in die Wissenschaftskommunikation involviert zu sein. Aber wie ich Ihre Frage wiederhole und erneut niederschreibe, muss ich bekennen, dass mir diese Formulierung überhaupt nicht gefällt. Es wäre wohl eher eine Chance für die Wissenschaftskommunikation und nicht für die Kunst, wenn die Kunst der Wissenschaftskommunikation etwas unter die Arme griffe.

Und da zukünftige Entwicklungen bei Ihnen liegen, ist es Ihre Aufgabe, Ihr Kunstverständnis und Ihre kulturelle Bildung jeden Tag zu erweitern und zu schulen. ■

"Scientiis et artibus" – "Den Wissenschaften und den Künsten": Das Gründungsmotto der Universität über dem Tor zum Innenhof. Bild: Albert Scharger

CreaThesis

Abstract

In a world where science is exceedingly complex and has a major impact on everyone's daily life, it is more important than ever to communicate science in a way that is accessible to a wider public. Yet, science communication is a skill often overlooked at universities and research facilities.

In our project, we tried to find ways to strengthen this skill. We encouraged students to create an artistic interpretation of selected aspects of their scientific thesis, a *CreaThesis* that is accessible to people who are not familiar with the subject. To assess the development of their science communication skills, the participants answered a survey based on the science communication training effectiveness scale before and after creating their *CreaThesis.*

We then evaluated how the perceived scientific communication skills of the participants changed as a result of their participation in the CreaThesis project. Overall, we detected a nominal increase in oral presentation skills, expectations of a positive outcome, and science communication skills of the participants after they created their *CreaThesis.*

The results do not show statistical significance but indicate a trend that supports the hypothesis that creative presentation of scientific work increases perceived science communication skills. Our approach is thus worth pursuing further, taking into account its limitations and the barriers to participation.

1. Background

Scientific research has been practiced over centuries and improved constantly. Eisner and Powell (2002) argue that each practice can potentially be considered as art and that science and art are not dichotomous (Eisner & Powell, 2002). Like a mutual exchange, they positively inspire each other over a wide spectrum. The art in science has the ability to inspire, motivate, and enrich scientific work (Eisner & Powell, 2002).

But what is art?

It is hard to find a definition that captures all the different aspects "art" can *have*, *be*, or *produce*. The definition varies depending on who you ask. However, Hubert Ehalt (2009) gave a very elaborate explanation on the attributes of art during the Vienna lectures:

"The goal of the arts is to create pieces where shape and content form an indissoluble unity. [...] Art does not exist and has never existed; only the artwork exists." (p.16). And further: "In arts, the artwork emancipates itself from the artist. [...] There is this unwritten rule [that] the artists remain silent in regard to their work." (p. 18).

Many scholars have thought about art and its value. For example Goethe said: "one does not avoid the world so easily as through art and one does not interrelate with it so easily as through art" (Goethe, cited from Böhm, 2013, p. 35). The writer Colum McCann said that "art is one method to cope with the world by laying it under the microscope." (McCann, 2017, p. 83). Seeing art through the scientific lens, it was found that art (as music) is able to evoke emotions, increase engagement in spontaneous, self-referential cognitive processes and influence physical performance and regeneration (e.g., Bhattacharya & Lindsen, 2016; Taruffi et al., 2017; Thompson, 2009; Karageorghis et al., 2021). In regard to learning, there are even more forms of art that can help to encode and store information in the long-term memory. For example, writing a story, or drawing a picture, entailing information that has to be learned leads to (a) the generation of content and background, (b) a deeper elaboration, and (c) a rehearsal of the information, and, hence, to a more elaborate memory trace (Rinn et al., 2011). Furthermore, art production, in comparison to mere art perception, increases the functional connectivity in brain areas that are related to stress resistance (resilience) (Bolwerk et al., 2014). And does not everyone of us need more stress resistance?

But speaking about scientific facts of art – what is science?

Hubert Ehalt also gave a very elaborate explanation on the attributes of science during the Vienna lectures (2009):
"Research and science are processes of development [...] and the disclosure of new perceptions and ways of thinking. What was previously [state of the art] gets automatically a character of a "prestage". [...] "Sexy" means in science the most recent result. [...] In science, and especially in natural sciences, the main purpose is to find effects, functionality and their connection, obvious or obscure casualties [...]. It is essential that the theorem is correct, not beautiful. [...] This distinguishes art and science." (p. 17)

For our project, we mainly see art as a way of communicating. For more than tens of thousands of years, stories, paintings and pictures have been used to share information with a broader public. All these forms of art have in common that they are (to a certain extent) emotional, personally relatable, and exciting – attributes that are desirable for the general audience, but which are not necessarily included in scientific publications. There, the most important content should be provided as plainly and succinctly as possible. No repetition, no rhyme. Rarely, you find suspense. This is not a severe issue when scientists communicate with colleagues (science-to-science communication), as all the recipients are familiar with the rules and structure of a scientific publication, but it can become problematic if scientists want to share their results more widely, or even with the general public (science-to-public communication). What if we provide scientific information in more (and probably "better") forms? What if we "[borrow] communication strategies from the arts […]"? (Martinez-Conde & Macknik, 2017, p. 8127)

We hypothesize that creativity, and possibly also a version of art, provide additional support for a good research idea, innovative methods, and sound and understandable science communication.

As the above summary shows: one can find support for the assumption that art and science work best hand in hand. Therefore, our research question was:

Does the participation of students in CreaThesis increase the perceived science communication skills of the participants?

2. Goals and Methods
2.1 Goals
The main goal of our project was to improve students' science communication skills. In this context, we investigated whether the creative engagement of students with their own scientific work and the easily understandable presentation of the results would lead to a self-perceived improvement of their own science communication skills.

In addition, the project also aimed to achieve these further goals:

1. To give other students the opportunity to obtain an impression of research areas outside their own field of expertise and more generally stimulate scientific exchange through presenting the submitted creative contributions publicly on a website (https://creathesis.ja.tum.de/) and on social media.

2. Generate more attention for the scientific achievements of students.

2.2 Methods
2.2.1 Pilot Study Survey
To assess the acceptance of the project, we conducted an exploratory evaluation. For this purpose, we constructed a survey based on a 5-point Likert scale ranging from 1 (very low) to 5 (very high). A representative question used for the questionnaire is "Based on the description you read about CreaThesis, how high is your interest in participating". With such questions we wanted to: (a) evaluate the interest of students in participating in the project; (b) determine which incentives we should provide that could support students' needs; and (c) find out whether students are interested in looking at the creative work of other participants.

2.2.2 Website Design
In order to present the contents of the CreaTheses created by the participants to the general public, we developed a website. This was designed by our team and hosted via the standard webhosting provided by LRZ. Participants were asked to submit a CreaThesis as a creative reworking of their thesis or an aspect of their thesis. They were asked to write a simplified abstract and to provide basic data about the thesis (name of the author, field of study, supervisor, chair). This information has been made available on the website (https://creathesis.ja.tum.de/).

2.2.3 Pre/Post-Test Survey
To investigate our main Research Question, "*Does the participation of students in CreaThesis increase the perceived science communication skills of the participants?*", we applied a pre/post design which included two questionnaires. Prior to the intervention (i.e., creating a CreaThesis) we asked the participants to fill in the pre-test survey. The participants answered the post-test survey after the

intervention, that is, after submitting their CreaThesis. The goal of the survey was to measure and quantify students' self-perceived science communication skills. For this purpose, we adapted the *science communication training effectiveness scale* (SCTE) from Rodgers and colleagues (2020). The SCTE was designed to measure the effectiveness of science communication training. It has five dimensions: *motivation* (degree to which the participant is eager to learn new communication skills), *self-efficacy* (belief in being able to apply the new skill), *cognition* (acquisition of new knowledge), *affect* (cognitive representation of emotion), and *behavior* (goal-directed actions towards communication skill improvement). The authors used existing measures and modified them, as well as adding further measures. This led to a total of 17 items for the SCTE scale (Rodgers et al., 2020). The response format varies between 4-point, 5-point and 7-point Likert scales with different response possibilities (e. g. 1 = very insecure; 5 = very confident or 1 = not at all true; 4 = exactly true). As some of the items were not relevant for our purposes, we removed 31 questions in total from the original questionnaire. An additional 5 items were used to determine demographic variables as well as to understand how participants became aware of CreaThesis.

For the first part of the survey, we chose to include nine questions from the domain *self-efficacy* (e.g., "I can always manage to solve difficult problems in science communication if I try hard enough."), five questions focused on science communication and four questions focused on self-confidence during oral representations (e.g., "How would you rate your level of confidence in your ability to give a scientific talk to a lay audience?").

The second part of the survey focused on the dimensions of *cognition* and *affect*. The dimension *cognition* was used to determine whether perceived knowledge about science communication increased through the participant's own engagement with the topic (e.g., "My science communication skills make me feel well prepared for my next presentation."). The six questions chosen from the *affect* domain should provide insight into whether the participants have gained a more positive attitude towards science communication as a result of the intervention and are more satisfied

with their skills in this area. In general, the SCTE shows sufficient validity and reliability. However, as we altered the original questionnaire, the originally reported psychometric scale properties must be considered with caution.

2.2.4 Evaluation of the Website Data
To measure whether the submissions published on the website led to more attention for the participants' scientific results, the website data was analyzed using the Matomo Analytics tool. This allowed information to be collected on the number of visitors, visit times, and visitor behavior on the website while still using minimally invasive tools, protecting users' privacy.

3. Outcome and Discussion
3.1 Outcome
3.1.1 Pilot Study
The pilot study was conducted in May 2021 and revealed a high interest among participants in participating in the project (Number of participants N = 108, Median M = 3.685, Standard deviation SD = 0.963). The exact distribution of the interest in participation is presented in Figure 1. The study also showed that the participants preferred examples (87% of participants) and precise guidelines (64% of participants) to assist them in creating their own CreaThesis.
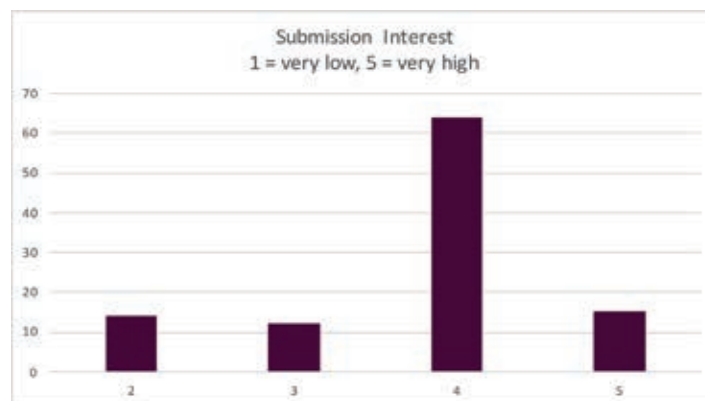

Figure 1: Distribution of the submission interest of participants found in the pilot study.

Regarding the support types, students were generally interested in different ones overall. Still, examples of CreaTheses and guidelines seemed generally more attractive to most than the support of art students. The exact results can be seen in Figure 2.
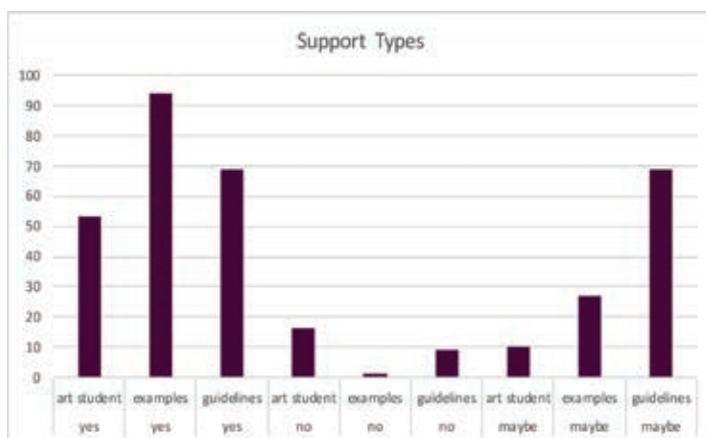

Figure 2: Distribution of the support types students indicated as preferences when creating a CreaThesis.

Finally, participants of the pilot study were asked about which incentives would motivate them the most to actually develop their own CreaThesis. Overall, it became apparent that students were not primarily motivated by monetary or other material incentives, but rather by intellectual curiosity, their possibility to learn something about science communication, as well as to use the participation as a highlight on their own CV.

3.1.2 Website
In October 2021 we were able to launch our website (https://creathesis.ja.tum.de/). The homepage can be seen in Figure 3. It contained information about our project and how to participate. CreaTheses created by the team were also presented to provide participants with an inspiration for their work. Each CreaThesis submitted by the participants was later presented on the website in a gallery format, seen in Figure 5.

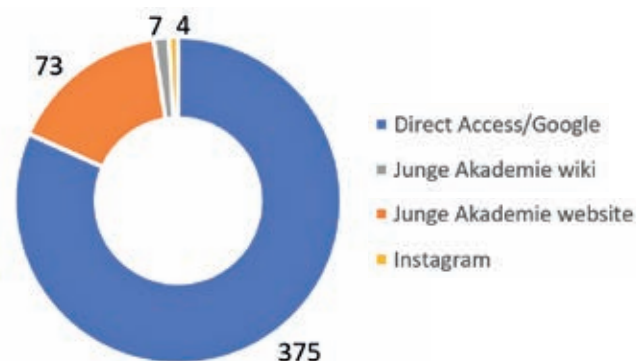Figure 3: Homepage of the CreaThesis website.

Figure 4: Access points to the website.

By analyzing the website data, it was possible to determine that our website was visited by a total of 461 people, with an average visit duration of 8 minutes. A large number of the visitors opened the website via direct access (Google, QR code, address entry) (n=375). The second largest group of visitors came from the TUM: Junge Akademie website (n=73) and some from the TUM: Junge Akademie wiki (n=7). From the Instagram channel, only four visitors accessed our website (Figure 4). The results point to a general interest in the project but also suggest that there were some barriers to participation or that the target group was wrong.

Figure 5: Part of the gallery consisting of CreaTheses designed for the project.

Figure 6: CreaThesis "Research to improve the quality of proso millet malt for the brewing process OR How to make beer from proso millet malt" by Magdalena Bader.

Figure 7: CreaThesis "Physical Unclonable Functions (PUFs)" by Veronika Bauer.

Figure 8: CreaThesis "The Integration of a new silverback male into a group of female gorillas" by Annika Neuhaus.

3.1.3 Submitted CreaTheses

The forms of artistic representation chosen by the participants were diverse and included photographs, sketches, schematics, and poems. They also covered a wide range of topics such as "Research to improve the quality of proso millet malt for the brewing process OR How to make beer from proso millet malt" (Figure 6), "Physical Unclonable Functions (PUFs)" (Figure 7), and "The Integration of a new silverback male into a group of female gorillas" (Figure 8).

3.1.4 Descriptive Results

A total of $N = 4$ participants handed in a CreaThesis and completed both of our surveys. The distribution of different descriptive variables can be found in Table 1.

Variable	Group	n	M	SD
Gender	Male	2	-	-
	Female	2	-	-
Age	-	-	24.75	1.71
Study Level	Bachelor	1	-	-
	Master	2	-	-
	PhD	1	-	-
Faculty / School	School of Life Sciences	2		
	Faculty of Mechanical Engineering	1		
	Other University	1		

Table 1: Overview of descriptive statistics.

Additionally, all participants were made aware of CreaThesis by friends or fellow students and said they were very likely to recommend CreaThesis to their friends (all answered 5 on a 5-point Likert scale). Likewise, one participant said he or she was likely to participate again, whereas three said they were very likely to participate again.
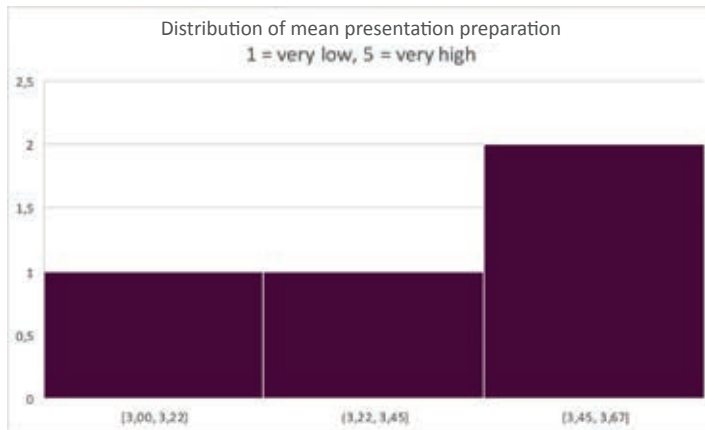
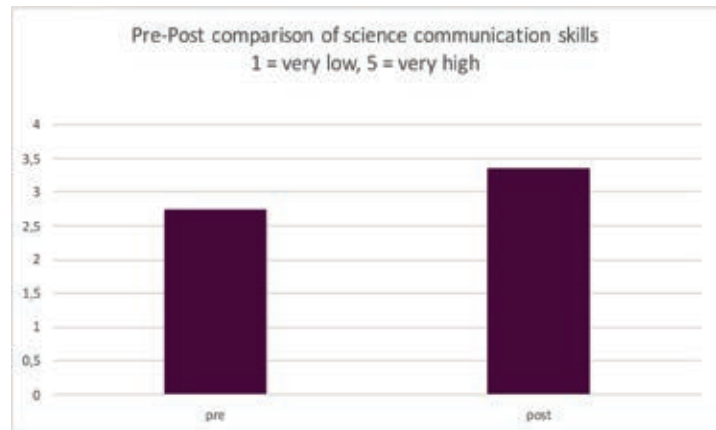Figure 9: Distribution of mean presentation preparation.

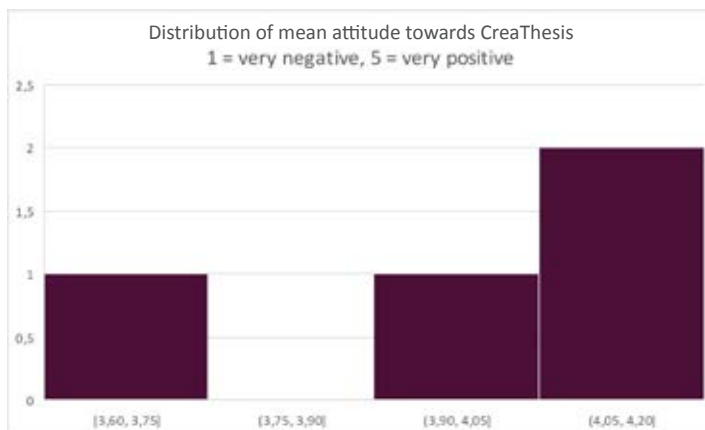Figure 11: Pre/Post comparison of science communication skills.

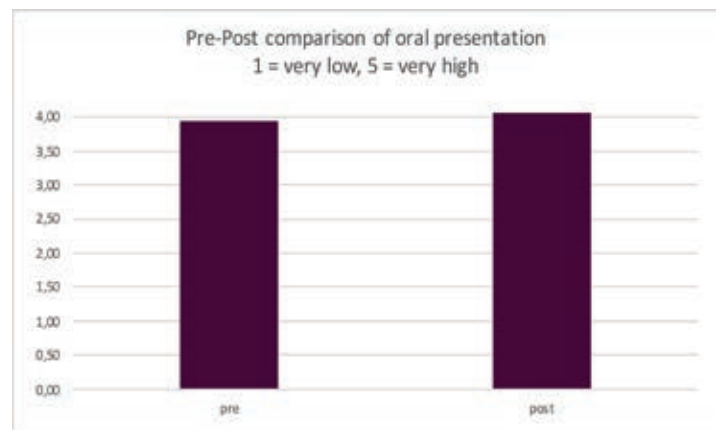Figure 10: Distribution of mean attitude towards CreaThesis.

Figure 12: Pre/Post comparison of oral presentation.

Regarding the preparation for the presentation, most participants were medium to medium-high prepared as can be seen in Figure 9.

Further, most users had a medium to medium-high attitude towards CreaThesis as can be seen in Figure 10.

3.1.5 Pre/Post Comparison
All participants completed the same questionnaire before and after participation in CreaThesis. On average, the participants' belief in their science communication skills increased after participation in CreaThesis as shown in Figure 11. Before the participation, the average score was 2.75 (SD = 0.53), whereas it was 3.35 after participation (SD = 0.1).

Additionally, participants' beliefs in their oral presentation skills very slightly increased after participation (Figure 12). Before, they had an average of 3.96 (SD = 0.315), whereas they had an average of 4.06 (SD = 0.125) after participation.

Lastly, participants increased their positive outcome expectations in the participation of CreaThesis (e.g., "CreaThesis makes me stand out from my peers who are on the job market."). Here, the average before participation was 3.5 (SD = 0.274), whereas it was 4.07 (SD = 0.378) after participation (Figure 13).

3.2 Discussion
Based on the results collected during the project, we finally tried to evaluate whether the aim of the project, to improve students' science communication skills, had been achieved and whether the participation in CreaThesis did indeed increase the perceived science communication skills of the participants.

3.2.1 Data Interpretation
Although the results of the pilot study indicated a high level of interest in participation, the final number of participants was con-
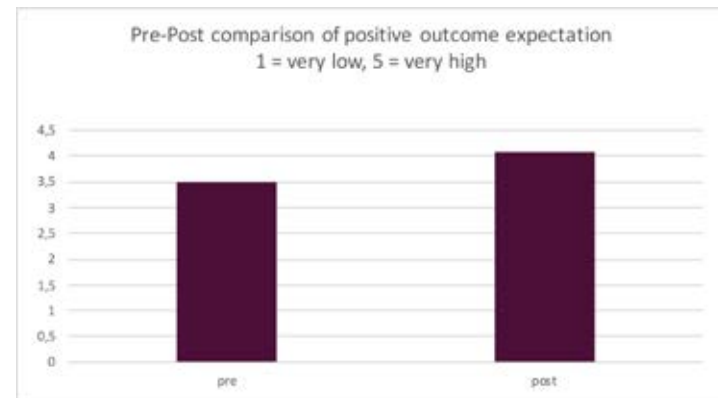

Figure 13: Pre-Post comparison of positive outcome expectations.

siderably smaller, with N = 4 at the time of evaluation. Possible reasons for this discrepancy will be discussed later. For the data analysis itself, however, this meant the evaluated results held no statistical significance. To achieve this, the number of participants would have had to be N = 64 (d = 0.5, β = 0.8, α = 0.05). We could therefore neither confirm nor reject our hypothesis. Yet, we can look at our results and evaluate them in order to find a preliminary trend.

Overall, after creating the CreaThesis, participants rated both their oral presentation skills and their science communication skills higher than before participation in the project. This trend in the data supports our hypothesis that the participation in CreaThesis increases the perceived science communication skills of the participants. The participants also displayed a more positive expectation regarding the outcome at the end of the project compared to beginning. This indicates that their participation showed them that they are capable of handling such tasks outside their usual area of expertise and can achieve success here.

Regarding the additional goals of giving students the opportunity to obtain an impression of research areas outside their own field of expertise and to generally stimulate scientific exchange with our project we can see our website as an important first step. The platform is now available and gives interested students insights into different scientific fields and into the work conducted by other students in an accessible way. This increases the visibility not only of the research topic but also of the thesis written by the students. It also illustrates an alternative way to present scientific topics using unfamiliar means.

3.2.2 Limitations and Potential Improvements
While the results described above already emphasize the importance between science communication and creativity, a different project course was initially intended. This was in essence dependent on a higher number of participants. Several considerations are made as to why this number could not be achieved.

In the first place, it is assumed that many potential participants were deterred by the time involved in writing a CreaThesis. Unfortunately, there are no exact figures on the actual time required by the participants to create their CreaTheses. In particular, students who had not been creatively active recently might not have been able to confidently estimate the time required to complete a CreaThesis, which discouraged them from participating. Moreover, the low participation rates could be due to the fact that with CreaThesis a new offer was addressed to students, the added value of which could not yet be confirmed by a large number of experience reports. Thus, participation could have been a time-consuming risk for students, which they did not want to take due to the uncertainty of the resulting benefits. Various measures, such as the distribution of a participation certificate or a detailed description of how participation in CreaThesis can beneficially be mentioned in job interviews, were implemented to make it clear that this time investment could also be rewarded with potential benefits. In addition, monetary incentives were used. However, all of that did not appear to have been worth the time investment for most individuals.

A second aspect that may have had a strong influence on willingness to participate is the Covid-19 pandemic, which continues to this day. This could have been reflected in the fact that it was difficult to create the necessary visibility for our project among students due to an almost exclusive online presence. As there was hardly any face-to-face teaching during the project, fewer students were present at university facilities, and it was not possible to use physical advertising materials such as posters in lecture buildings. This is unfortunate, as, from such print materials, we had hoped for an influx of participants which we were unable to reach through TUM: Junge Akademie channels. Moreover, due to online lectures, most students have recently spent a lot of time alone in front of their laptops anyway, which may have made an online offering like CreaThesis even less attractive, since it would mean additional hours of working time with a laptop.

The third point to mention is that we collectively overestimated the motivation of potential participants based on the first survey. As a result, measures were derived that did not reflect the rather low level of interest in participating in CreaThesis among the student body. The very positive results of the first survey may have been due to social desirability, meaning that participants answered in a way they expected us to approve of. Furthermore, the general interest in and demand for CreaThesis, i.e., not only on the part of potential participants, but also on the part of potential consumers of the submitted CreaTheses, was overestimated. As a result, it was not possible to gain the desired level of attention for the project through, for example, word-of-mouth or sharing our advertising resources. This in turn had a negative impact on the appreciation and attention potential participants could expect for their submitted CreaThesis, so that this fueled the above-mentioned aspect of the insufficient benefits of creating a CreaThesis. Perhaps most students and other members of university and academia do not see the lack of interdisciplinary communication as a major problem, or our project effort was not sufficient to make them aware of it.

3.2.3 Project and Resource Management

One of the biggest setbacks was the lack of demand since we had to invest an ever-increasing amount of effort into marketing and recruitment. That could have been avoided by checking the demand more thoroughly. Even though an initial survey was conducted that showed promising results, we now believe that there was a response bias in the data that could have been reduced by finding a more heterogeneous group of study participants. We also should have insisted on a larger group of participants before continuing with our work. Being critical towards your own ideas and making strategic interventions throughout, especially after investing lots of time and energy, are some of the hardest but most crucial things to do. Another aspect was the overall project design. Instead of designing it around the needs of our participants, we constructed it in a way that was the most suitable for us.

Above all, we encountered real-world problems, made sub-optimal choices, encountered aggravated Covid conditions and had a too positive attitude towards our idea. Being more critical and trying to picture the project from an outsider's viewpoint would have helped to build an environment that would have fostered collaborative participation. Incentives are also often overlooked. We as scholarship holders already have an incentive to push forward with our project but that does not apply to prospective participants. Giving out ECTS credits or certificates of participation with a higher visibility would have helped to incentivize. Additionally, we scheduled meetings to discuss and delegate work that was then handled in subgroups or alone. Instead, we could have tried to schedule working sessions that doubled-up as meetings. That would have eliminated slack and would have led to a quicker response to problems within our project idea, while also boosting team coherence.

Another aspect that affected our lack of participants was marketing. A big takeaway for future projects is that there is no such thing as "too early," when it comes to marketing. Hang up more posters all over TUM, or in the light of the pandemic, exhaust the full potential of Instagram and LinkedIn marketing. As you can see from our data, we were only able to funnel four users of Instagram to our website, which is a disappointing conversion rate. One could have contacted the TUM Instagram account or asked for a spot on the TUM website.

We also lost traction because our focus shifted to other side activities like applying to programs like the Deloitte Hidden Movers Award or dreaming of fancy art happenings with students of the HFF or ADBK. These sorts of activities do not help one's project while it is still in the design phase, but they do tie up important resources.

Finally, especially when dealing with projects that demand a fair share of self-initiative from students, live or in-person workshops can lower the "entry barriers". Workshops would have also helped to spread the word since they are recruiting and marketing measures all in one. Keeping in mind that workshops or events require preparation and planning that can not be done at short notice, such ideas need to be incorporated early on in a long-term strategy. So, start early and factor in drawbacks. Most things will require more resources than anticipated and as always: the devil is in the detail. Building a website and hosting it on the LRZ webspace took a lot longer than planned and posters or slide decks can not be designed overnight, just to name a few. Speaking of project management: it is advisable to build teams of two for important tasks such that the break of one person due to exams or vacation can be absorbed better.

4. Self-reflection

In terms of self-reflection, a deeper look at the internal processes within the team CreaThesis are worth mentioning. As such, the ongoing Covid pandemic not only presented a challenge in recruiting participants, but also had an impact on internal work within the team – eventually, behind a successful project stands a motivated and well-run team. First, working from home in isolation and the lack of communication in person had a negative impact on team cohesion and motivation for the project. Thus, the online meetings were very work-related and activities such as ordering food togeth-

er and socializing in the office, which were otherwise highlights of the TUM: Junge Akademie's daily project life in previous years, were omitted. Get to know each other, have fun and plan events. That will boost morale and motivation and will develop a long-lasting commitment to the team and project. Fun activities are what brings teams together. There was definitely a lack of social activities (mostly due to Covid) but even during times where rules were eased, the possibilities for reimbursed team events were rather small. In addition, getting to know each other digitally is often less intensive than getting to know each other face-to-face, and becoming comfortable with each other and trusting each other took longer at the beginning. Also, digital communication was sometimes less efficient than a face-to-face one probably would have been, which in turn made decision-making more time-consuming. Nevertheless, it should be noted at this point that there were no interpersonal difficulties or insurmountable conflicts within the group at any time.

5. Summary and Future Goals

Even though the obtained results from our survey were not statistically significant due to the low number of participants, it still provided us with valuable insights. The post-tests showed that participants had improved their perceived science communication skills after completing their CreaThesis. Even though results are, at maximum, qualitatively interpretable, they indicate a positive impact by our Project. Therefore, we really hope to have sparked the University's interest and wish that our idea finds its way into future projects of TUM's lifelong learning or Pro Lehre efforts. After all, students produce interesting papers every year and most of them are only read by a few people at best. Great works deserve a higher visibility which in turn would improve science communication, exchange and maybe even evoke curiosity in some future scientists.

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Self-reflection

von Andrea Schittenhelm und Nico Michel für Team CreaThesis, Class 2021

Note. The self-reflection is primarily a mirror of our thoughts, emotions, actions, and reactions. At some point also a journal entry of our meetings and team events. Therefore, we would like to present it in the original language of our operational mode. We hope you enjoy our language-based artwork – which was in this form only possible to compose in our mother tongue.

However, we tried to translate it with all its fine shades and shards of mirror fragments into English. You can find it below.

Vorwort zum semi-fiktiven Interview ohne Fragen:

Semi-fiktives – WAS?!

Das, liebe Leute, ist die *CreaThesis* von *CreaThesis*.

Abdrücke, Eindrücke, Fragmente vieler Augenblicke; Fetzen der Diskussionen, welche wir in den letzten 20 Monaten erlebt – oder eher durchlebt – haben.

Fein säuberlich zusammengetragen, gewaschen, getrocknet, zerpflückt und wieder neu zusammengesetzt. Der Anspruch an unsere CreaThesis war also kein geringerer als die künstlerische Gestaltung und Darstellung eines gesamten Projektes und dessen acht Mitgliedern.

Semi-fiktiv, weil wir keine Garantie dafür geben, dass die dargestellten Inhalte wirklich so in der Welt, die die meisten von euch als Realität ansehen, geschehen sind. Jedoch geben wir die Garantie, dass dieses »Interview« – die Einsicht in das Wechselseitige, das Dazwischen, das Nicht-ausgesprochene, das Zerriebene der Projektgruppe – zeigt, welche nachhaltigen Eindrücke das Projekt bei uns hinterlassen hat.

Viel Spaß!

Marlon ist noch nicht da. 3 Minuten warten wir noch…

Jetzt?

Also ich hab jetzt auch nicht nachgesehen, aber ich denke das sollte passen…

Hallo?

Ja ich hab das auch verifiziert. Die Tonaufnahme läuft.

Hören Sie mich?

Ja!

Ah, gut. Super. Also wie ich Ihnen gerade schon sagte, Nico, ich habe nicht viel Zeit.

Ja, dann mach ich mal den Anfang. Mir gehts heute gut soweit. Der Kopf tut gar nicht so arg weh. Ähm, meine Lieblingsblume… puh. Ich würde sagen, dass ist der Kaktus: Ist pflegeleicht und vertrocknet nicht so schnell. Und darauf freue ich mich im Sommer…chillen an der Isar mit nem guten Wein in der Hand.

Joa, mir gehts heute auch soweit ganz gut, bin an Staatsexamen Lerntag #3 angekommen, und habe schon keine Lust mehr – nur noch 97 Tage to go; yeah! Ja was mache ich am Wochenende, ich denke da mache ich erstmal frei.

Und meine Lieblingsblume – schwierig, ich mag so viele Blumen, da kann ich mich gar nicht so richtig entscheiden, ähm… die Pfingstrose!

Also mir gehts auch gut. Kam gerade vor 5min erst aus dem Labor heim und direkt ins Meeting. Blumen, joa also bei mir vertrocknet so die ein oder andere Blume gelegentlich mal, obwohl ich das ja eigentlich können sollte so als Biologe *(lacht)*. Sommer, ach ja da steht dann die Masterarbeit an *(streicht sich die Haare aus dem Gesicht)*. Also das sehen wir dann aber…joa.

Mir gehts auch gut so weit. Sitze an meiner Masterarbeit, keine Ahnung was danach aus mir wird. Burnout-Klinik? Dafür war ich heute morgen schon um 6 mit Tobi pumpen. Dank mir drückt er jetzt 5 kg mehr auf der Beinpresse. Und ich genieße jedes Mal Treppensteigen dafür, danke! Blumen, ich glaube die an meinem Fenster *(dreht die Kamera)*, die ist schon 7-mal mit mir umgezogen und ihr gehts immer noch gut und blüht so schön. Sommer?! Endlich wieder in die Berge!

…Ja! Hallo erstmal an alle! Ich hoffe Sie können mich alle gut hören! Was war die erste Frage nochmal?

Ja. Ja *(seufzt)*. Also, man musste sich ja letztendlich entscheiden. Also die Option jetzt ein komplett neues Unterthema aufzumachen, gab es ja nicht. Deswegen musste ich eine Wahl zwischen "Health" und "Science" treffen. Beide hatten Projektideen, die ich gut fand, aber eben auch Zeug, wo ich dachte, puh, muss das sein?

Hey Leute! Ich bin jetzt da. Um was gehts?

Ah ja! Ja das war eigentlich so, dass ich ja in "Business" war, aber dann sind die einfach gegangen und dann war ich da übrig und dachte, joa *(hebt die Schultern)*, dann muss ich wohl was anderes finden.

Ja also ich hatte da eigentlich keine Präferenz, aber es schien irgendwie zu passen.

Weil es im ersten Moment nicht zusammenzupassen schien. Ja, ich denke da kickte einfach meine Liebe zur Nonkonformität.

Ja und Wissenschaftskommunikation ist jetzt auch nichts, was man vernachlässigen sollte, somit war das schon ein gutes Thema.

Ja, ja. Das mochte ich gar nicht. Aber was soll man machen.

Ick wollte da eigentlich auch nicht mitmachen.

Ich hatte wirklich keine Lust auf ein Online-Seminar!

Yeah - Team rote Corona-Warn-App…

Wir?

Ne, die anderen…

Achso.

Aber prinzipiell war es okay. Nur mehr Pausen wären gut gewesen.

Ich hatte wirklich keine Lust auf ein Online-Seminar!

Jaaaaa *(dreht den Kopf)*. War nich so nice. Aber wir waren ja zu zweit, also dafür war es schon ganz gut. Und Nico hat frische Brötchen gebracht *(grinst)*.

Ich hatte *wirklich* keine Lust auf noch ein online Seminar!

Das war eher…interessant. Auch ein wenig verstörend. Und sehr eng. Aber es hat unser Zusammengehörigkeitsgefühl auf jeden Fall gestärkt.

– Erzählerischer Rückblick –

Nico? Hallo? Hörst du uns?
JA! ICH KANN EUCH HÖREN!
Wie geht es dir?
ICH BIN FESTGEKETTET!
Was?!
ICH BIN FESTGEKETTET!
Siehst du was?
JA, DA IST EIN ROTES LICHT AN DER WAND!
Kommst du da ran?
DAS BETT FÄHRT HOCH!
Okay…
DAS LICHT IST AN!
Okay…
Weiß jemand was Knoblauchbrot hier genau ist?
(Stille)
Entschuldigen Sie, was ist denn alles auf dem Knoblauchbrot drauf?
Ähm, Brot. Und Knoblauch.
Ah ja…danke!
(Stille)
(Jemand prustet)
Schönes Gewölbe haben sie hier übrigens.

– Erzählerischer Rückblick ENDE –

LEUTE! Wir müssen weitermachen, sonst werden wir hier nie fertig!

Achso ja, also das kam, weil Dr. Irber sagte, er sieht auf der Website acht schlaue Köpfe aber nur zwei CreaThesen...

Das war reeelativ schwierig und dann wieder nicht *(lacht)*. Also wenn man dann mal was gefunden hat und eine Idee einen nicht mehr loslässt, dann probiert man noch 2-3x rum und dann hat man's eigentlich. Dann muss man nur noch den Hintern hochkriegen und den Text schreiben. Also wie bei der eigentlichen Thesis – ähnlicher Prozess würde ich sagen.

Im Prinzip hat es schon ganz gut funktioniert, ich mein, wir hatten von Anfang an gute Ideen, wir mussten uns dann nur für eine entscheiden.

Ja, also bei mir war es schwierig, jetzt wegen den Klausuren und den Daten für meine Betreuerin.

Bald. Ich hab einfach immer "bald" gesagt und das hat erstmal für ein paar Monate gereicht *(lacht)*.

Ich hatte immer was im Kopf, aber an der Umsetzung… meine kommt sicher ein bisschen mehr als bald! Aber sie kommt *(hebt den Finger)*.

Ja also ich hab ja keine Bachelorarbeit, ne, Leudde *(lehnt sich zurück und grinst)*.

Also ich finde, dass haben Sie alle schon sehr gut gemacht. Ich hatte das auch nochmal an meine Studierenden weitergeleitet und denke, da kommt auf jeden Fall was zurück!

Leute, so am Rande, wir haben übrigens die erste Einreichung!

Wow! Hat die jemand angeheuert oder hat sie einfach so mitgemacht??

Peter hat auch gemeint er könnte da noch was einreichen. Man bräuchte vermutlich nur eine Horde wilder Designer die seine noch wilderen Ideen ordnen können.

Und wie lange warten wir dann auf eine Antwort von ihm? Weil public geht das Ganze nach Launch.

Uf jede Fälle bräuchtet ihr da noch was, dass des n bisschen au attraktiver wir' für de externe Eireichungen. Also des halde ich für ne gudde Idee.

Wir treffen uns eigentlich regelmäßig alle 2 Wochen. Von Anfang an. Auch an Weihnachten.

Ja, und wir waren auch immer vollständig.

Oh shit, ich bin nächsten Mittwoch in Berlin und weiß noch nicht ob ich abends dazu kommen kann.

Oder zumindest fast immer.

Ach shit, ganz vergessen zu sagen... Ich fahr gleich in Urlaub.

Sorry, ich habe heute Abend noch einen wichtigen Termin für die Arbeit!

Fast.

Auf jeden Fall brauchten wir noch einen Instagram Aufhänger und da haben unsere Marketing-Spezialisten die Memes erstellt. Daher die Postkarten. Und die Plakate!

Ehrlich gesagt hätten wir die Mülltonnen unter den Banksy-Schredder hängen sollen.

– Erzählerischer Rückblick 2 –

(Lautsprecherstimme): Ihr braucht was Rundes, um es dort aufzuhängen.
Hey Leute, sie hat gesagt wir brauchen was Rundes!
Ja, aber was?
(Lautsprecher stimme): Schaut mal nach einer Sitzgelegenheit…
Der Rollstuhl, der Rollstuhl!
Tobi! Wir brauchen das Rollstuhlrad!
(Macht einen Wheelie) Oh, jetzt wo ich grad den Dreh raushatte…
Ok Leute, wir haben Druck hintenraus, ich glaub heute wird's nichts.
Ich hab gerade hingeschaut und gelesen: "Problem: Biased Models. Solution: Blind Dating" und war leicht überfordert.
Ich dachte das waren die Schlussworte.
Don't destroy their dreams!

– ENDE – ■

Preface to semi-fictive interview without questions

Semi-fictive – WHAT?! – This, dear reader, is the *CreaThesis* of *CreaThesis*.

An imprint, an impression, fragments of many moments, scraps of the discussions from the last 20 months, which we have experienced – or rather underwent – and collected.

Nice and neatly gathered, laundered and dried, disrupted and reconstructed. Our claim for this *CreaThesis* was not lower than to create an artistic representation of the entire project and its eight members.

It is semi-fictive, as we cannot guarantee that the portrayed contents have exactly occurred in the world, which most of you see as reality, as it is written down here. But we do guarantee that this "inter-view" gives insights into the interactions, the in-between, the non-expressed, the pulverized, the grated of our project group; which shows the lasting impressions the project had on us.

Have fun!

Marlon is not here yet. So let's wait for another 3 minutes.

Now?

So, I haven't checked it either, but I think that should fit…

Hello?

Yes, I have verified that as well. The sound recording is running.

Do you hear me?

Yes!

Ah, good. Great. So, as I just told you, Nico, I don't have much time.

Yes, then I'll start. I'm doing well so far for today. The head does not hurt that much. Um, my favorite flower...phew. I would say it's the cactus: it's easy to take care of and it doesn't dry up quickly. And what I'm looking forward to in the summer... chilling by the Isar with a bottle of good wine.

Joa, I'm also quite well so far for today. I have arrived at the state examination learning day #three, and I am already bored by studying all day - only 97 days to go; yeah! Yes, what to do on the weekend… I think I'm taking the weekend off.

And my favorite flower - difficult. I like so many flowers, I really cannot decide. Maybe the peony!

I'm also doing well so far. I'm working on my master's thesis, but I don't know what will happen afterwards. Burnout clinic? But I was already in the gym with Tobi this morning at 6 am. Thanks to me he now presses 5kg more on the leg press. And I enjoy climbing stairs every time, thanks for that! Flowers… I think the one at my window (*turns the camera*). It has already moved 7 times with me, and it is still fine and blooms so beautifully. Summer? Finally, back to the mountains!

...Yes! First of all: hello to all! I hope you all can hear me well! What was the first question again? Could you repeat it please?

Yes. Yes (*sighs*). So, in the end, you had to make a decision. Since the option to open a completely new sub-topic didn't exist, I had to make a choice between "Health" and "Science". Both had project ideas that I liked, but also stuff where I thought, phew, does it really need to be like that?

Hey guys! I am here now. What is it? What are we talking about?

Ah yes! Yes, that was so that I was in "Business", but then some of them left the academy, and I was left alone there and thought, yaa (*raises his shoulders*)... then I thought I must find something else.

Yeah so, I didn't really have a preference, but it seemed to fit somehow.

Because at first it didn't seem to fit together. Yes, I think this simply kicked my love for nonconformity.

Yes, and science communication is not something that should be neglected, so that was already a good topic.

Yes. I didn't like that at all. But what should you do?

I didn't really want to take part either!

I really didn't feel like taking an online seminar!

Yeah - team red corona warning app...

We?

No, the others...

Ah!

But basically it was ok. Anyways, more breaks would have been good.

I really didn't feel like taking an online seminar!

Jaaaaa (*turns his head*). Wasn't nice. But there were two of us, so it was pretty good. And Nico has brought fresh bread (*smiles*).

I *really* didn't feel like taking another online seminar!

That was rather...interesting. Also, a little disturbing. And very close-by. But it definitely strengthened our team cohesion.

– Narrative review 1 –

Nico? Hello? Can you hear us?
YES! I CAN HEAR YOU!
How are you?
I AM CHAINED!
What?!
I AM CHAINED!
Do you see anything?
YES, THERE IS A RED LIGHT ON THE WALL!
Can you reach it?
THE BED GOES UP!
Okay...
THE LIGHT IS ON!
Okay...

Does anyone know exactly what garlic bread is like here?
(*Silence*)
Excuse me, what's all on the garlic bread?
Um, bread. And garlic.
Ah yes...thank you!
(*Silence*)
(*Someone splutters*)
Beautiful vault they have here, by the way.

– Narrative review END –

**PEOPLE! We have to keep going,
otherwise we'll never finish here!**

Oh yeah, so that came up because Dr. Irber said he sees eight smart heads on the website but only two CreaTheses ...

That was relatively difficult and then again not (laughs). So, once you've found something and the idea won't let you go, you try around 2-3 times and finally you've got it. Then you just must get your ass up and write the text. Just like with the actual thesis - a similar process I would say.

Basically, it worked quite well, I mean we had good ideas from the beginning, we simply had to agree on one.

Yes, so for me it was difficult because of the exams and the needed data for my supervisor.

Soon! I just kept saying "soon" and that was enough for a few months (laughs).

I always had something in mind, but the implementation... mine certainly comes a bit more than soon! But it is coming (raises one finger).

Well, I don't have a bachelor's thesis yet (leans back and grins).

So, I think that you have all done very well. I had also forwarded this to my students again and I think, this time there is definitely something coming back!

Guys, by the way, we have our first submission!

Wow! Did someone hire her, or did she find us on her own?

Peter also said he could submit something. You would probably only need a bunch of wild designers who can organize his even wilder ideas.

And how long do we wait for an answer from him? Because the whole thing goes public after launch.

In any case, you still need something to make it a bit more attractive for the external submissions. So, I think that's a good idea.

We actually meet regularly, every 2 weeks. From the beginning. Also at Christmas.

Yes, and we were always complete.

Oh shit, I'm in Berlin next Wednesday and don't know yet if I can make it in the evening.

Or at least almost always.

Oh shit, I forgot to tell you... I'm about to go on vacation.

Sorry, I have another important work appointment tonight!

Almost.

In any case, we still needed an Instagram hook and that's where our marketing specialists created the memes. Hence the postcards. And the posters!

Honestly, we should have hung the trash cans under the Banksy shredder.

– Narrative review 2 –

(*Speaker voice*): You need something round to hang there.
Hey guys, she said we need something round!
Yes, but what?
(*Speaker voice*): Look for a seating possibility
The wheelchair, the wheelchair!
Tobi! We need the wheelchair wheel!
(*Makes a wheelie*) Oh now that I just knew how to get the hang of it!
Ok guys, we are under pressure, I don't think anything will happen today.
I just looked and read, "Problem: Biased Models.
Solution: Blind Dating" and was slightly overwhelmed.
I thought those were the closing words.
Don't destroy their dreams!

– THE END –

CREATHESIS

TUM

WHAT IS *CreaThesis* ABOUT?

With our project *CreaThesis* we aim at improving science communication between the students of different scientific domains of TUM. Participants elaborate sub-aspects of their own scientific theses in a creative manner to generate something new: a *creathesis*.

There are no limits for the designs, the participants can express themselves freely and use techniques of their choice, e.g., painting, drawing, poetry, etc. *CreaThesis* is not about making professional art but about gaining experience in communicating scientific results to non-specialists and to raise awareness and create passion for research topics.

The unique form of publishing scientific results creates a high memorability, by which schools and departments can raise awareness of and draw attention to their research topics. Thereby, they can awake curiosity and enthusiasm for their work and thus recruit future students. Furthermore, this can promote exciting interdisciplinary cooperation.

OUR MOTIVATION

As science communication is a competence currently far too little practised, *CreaThesis* offers students a chance to train this skill. Importantly, we want to raise awareness of the scientific work conducted by students and to show appreciation for their passion.

OUR STRUCTURE PLAN

OUR TIMETABLE

MAY 2021

MEMBERS: Alix Bertrand, Marion Demandt, Theresa Franz, Anita Kolmann, Nico Michel, Andrea Schittenhelm, Philipp Strobl, Tobias Tiemeier

TUTORS: Sebastian Kaltenbach, Maximilian Wagner

SUPERVISORS: Ernst W. Mayr, Rolf Moeckel

inspired by
TUM: Junge Akademie

During the Kick-Off meeting, our team agreed that, contrary to general perception, science and art do not coexist as strictly separate fields, but overlap, interact, and often enrich each other. At the same time, we agreed that this fascinating relationship is rarely promoted in science and art education.

Based on this idea, we developed several outline proposals that would give the participants a new perspective not only on art, but also on their own field. We also wanted to give them the opportunity to expand their skills in an area that they were largely unfamiliar with and possibly apply these skills in their field later on.

One aspect we focused on quite early on was the field of science communication. On the one hand, it is of immense importance, but on the other hand, it is hardly ever promoted in science teaching.

Consequently, we focused on proposals that allowed us to combine these two topics and thus developed our final project idea: *CreaThesis*. In this project, students explain their often very interesting but rarely communicated theses in a way that even people outside their field can understand. To do this, they had to look at their own work from a new angle and design a creative, artistic elaboration, their very own *CreaThesis*.

Once we had finalized our idea, we developed an initial structure plan and timeline and got to work to make the project a reality. ■
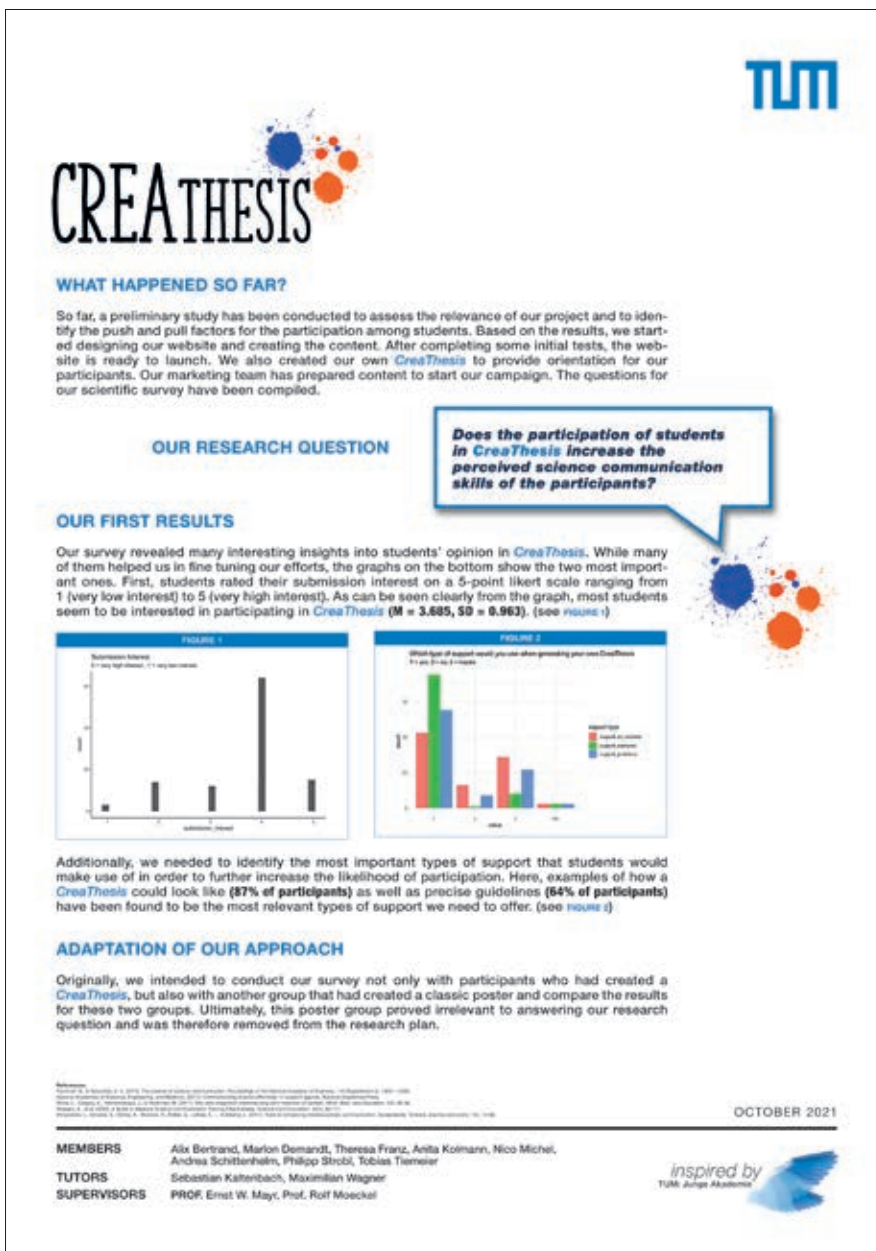
POSTER 2:

First, we conducted a pilot study to determine whether and for what reasons the project would appeal to our target group –the students at TUM. Here we were able to determine a high level of interest among the survey participants. In addition, we were able to determine that a majority considered the suggestions we came up with to be helpful in supporting their *CreaThesis*. Offering examples was welcomed by most of the participants. A general guideline was also seen as a good idea, while the possible contact with art students elicited rather mixed reactions. The positive feedback reinforced our assessment of the relevance of our project for the target group, and the differentiated responses helped us to further refine our project and prioritize our next steps. The main goal was to launch our website, where the *CreaTheses* would be published, as soon as possible.

We conducted more literature research to base our approach on a strong scientific foundation. Based on this research and feedback from our tutors, we developed our final research question. As a result, we discarded the idea of a control group, which now had no relevance to answering our research question. With our newly adapted approach, we continued with our work to get the project up and running. ◼

POSTER 3:

After months of intense work, valuable feedback from our tutors and supervisors, and cooperation with a variety of external partners, we developed, designed, and launched our website. Here, we not only provided important information about the project and the participation but also presented our own *CreaTheses*.

To answer our research question, we implemented a "Pre-test/Post-test" design that evaluated the participants' perceived science communication skills before and after creating a *CreaThesis* based on validated tests. We also determined the number of participants we needed for a significant result and thus set this as an intermediate goal.

To reach more people and motivate them to participate, we launched a large-scale marketing campaign. We contacted all chairs at TUM, distributed postcards and posters throughout the university, and launched our Instagram account. This led to the recruitment of the first participants who completed the pre-test.

We focused on two main aspects during this time: first, recruiting participants by pushing our social media campaign at all levels, and, second, using the experience we gained in the meantime to fix emerging issues with our website and submission process. ■

POSTER 4:

In the final phase of the project, small adjustments were made to the website and additional participants were motivated to take part. When all necessary steps were completed, we began a final summary of our project and a final analysis of our data. Although the number of participants did not allow for significant results, we were able to identify a statistical trend that supported our hypothesis. In addition to these results, we also describe our troubleshooting process to provide guidance on potential complications for projects using similar approaches based on our experience.

We also provide an outlook on a possible future for the project. Since all the necessary resources have already been created by our team, maintenance would probably be possible with little effort. But even without continued management, the current contents of the website give insight into different scientific areas and provides a valuable resource for current and future students.

As a team, we could conclude that by participating in the *CreaThesis* project and developing and implementing it, we all not only acquired new skills, problem-solving strategies, and perspectives, but also built a long-term network of contacts from a wide variety of fields that we hope to maintain beyond the project phase. ■

Project Report **elecTUM**

During our scholarship months, we united the topics climate change, the COVID-19 pandemic and our student life to study the new reality of TUM: that of online lectures. Under the lense of energy consumption, we decided to investigate whether online or on-site lectures would be the more sustainable option for TUM students. This investigation was done by developing a web-based calculator that had its input data based on the behavior of TUM students and on the general reality of students based in Munich.

Team   Maroua El Asri
             Alexander Holas
             Catherine Yngaunis Koch
             Joachim Leibold
             Alesia Prendi
             Tim Schlachta
             Anna Sophia Schmid
             Leonard Schmitt

Tutors   Maryam Tatari
             Sebastian Zäpfel

Supervisors Prof. Dr. Peter Annighöfer
             Prof. Dr. Sara Diana Leonhardt

elecTUM

Preface by the Supervisors

Prof. Dr. Peter Annighöfer & Prof. Dr. Sara Leonhardt

Efficient and sustainable energy consumption remains to be one hot topic of our time. Our group Team elecTUM has decided to approach this topic. Based on what they have experienced during the Covid pandemic they focused on online lecturing, which, obviously, had a massive effect on our societal life. Online lecturing reduced social interactions in general or transferred them to a digital form. However, it has also influenced our individual energy consumption, for example by reducing individual moving radiuses, driving or flying, while increasing the energy consumption of individual households, because people were forced to spend more time at home and partly also shifted office times to their home.

ElecTUM has decided to analyze and compare online lectures with traditional lecturing approaches in university lecture halls. The intention was to not only compare the two approaches, but also to identify the main drivers of energy consumption, which could then be targeted in the future to render lecturing more sustainable.

As supervisors, we had the pleasure to accompany a highly motivated, self-organized and independent group of young students with a highly diverse studying background. During the whole period, we also had to rely on digital formats and exclusively met in virtual space.

Supervisor insights

For me, **Peter Annighöfer,** as forest ecologist and one of the supervisors, I could observe a very interesting project, from start to finish, from the first project idea to the final substantial report. But not only this, I also enjoyed seeing and accompanying, how the group organized itself and how it made use of the various skills they had within the group, by delegating responsibilities among one another, respectively.

What is your research interest or motivation for science? My own research is focused in interactions of plants and the resulting ecosystem structures, dynamics and services. In addition to deepening the understanding of the interactions between different ecosystem components, the aim of my research is to further increase the predictability of ecosystem dynamics. Based on this foundation, recommendations should be developed for a sustainable and result-oriented management of forest and agroforest systems.

What special experience from your studies/career would you like to share with the scholars? During my time as Master student, but also later on in my career as PhD student, I have mostly enjoyed group work quite a lot. I was allowed to experience how much more productive a group could be in comparison to a single person. However, for a group to function it needs guidance, supervision, and a group benefits from a productive atmosphere and encouragement. My intention was to offer advice and share my former experience with the group.

For me, **Sara Leonhardt,** it was a great (and, as JuAK supervisor) first time experience to supervise and work with the elecTUM team. I was deeply impressed by their independent and incredibly well self-organized working schedule, which they maintained throughout the entire period despite the difficult pandemic situation that confined all training courses and social interactions to a purely online format. I am also very excited about the team's results, which show that travel, in particular by car and from distant locations, consumes by far the most energy. This results provides a highly valuable roadmap for TUM but also other universities, suggesting that student access to housing close or on campus will greatly decrease energy consumption and increase the sustainability of education. Given the current global situation, this is more important than ever.

What is your research interest or motivation for science? My own research background is in ecology, specifically the interaction between plants and insects and how this interaction framework is driven by chemistry, affects ecosystem functions and responds to biodiversity loss. I have always been intrigued by the complexity of interactions and processes found in natural ecosystems, in particular in tropical ecosystems, and in the underlying mechanisms. I primarily want to understand and provide insight into hitherto unknown or little understood ecological phenomena. But I also want to use this knowledge to combat biodiversity decline and to contribute to sustainable solutions for conserving our natural ecosystems.

What special experience from your studies/career would you like to share with the scholars? I have always followed by own interests and path, which, occasionally did receive very little support or appreciation by colleagues. Even though I found it extremely hard to move on when told that (quote) "this (topic) is boring with a capital BEE..", I am glad I did hang in there. The hardest part is to free oneself from the opinion of others, but I think trying is worth it. ■

Let's talk about the dilemma between social interaction and energy saving

After approximately one and a half years of networking, research, and programming, a group of eight students at the Technical University of Munich (TUM) came to the conclusion: online lectures prevail when it comes to choosing the lecture format with the smallest energy consumption – mostly due to energy-intensive means of transportation, such as metro or car.

In early 2020, with the beginning of the COVID-19 pandemic, TUM either canceled its lectures or switched them to an online format. Since then, even with short periods of normalcy, the university has not yet fully returned to its pre-pandemic state.

In November 2020, when TUM lectures were mostly being held online, the mentioned student group got together to investigate whether different lecture formats had an impact on the overall energy consumption of TUM students. From the beginning, their aim was to develop a calculator which would determine, based on different parameters, what lecture format was the most energy efficient.

Even though the research group started its project with the aim of helping to reduce TUM's energy consumption, it is aware that, for most TUM students, on-site lectures are more interesting from a social interaction and mental health point of view. Hence, the student group recognized a dilemma: on one hand, they want to reduce the energy consumption of TUM lectures, which means switching to online lectures; on the other hand, they recognize the importance of social interaction and campus life for a healthy graduation. To approach this dilemma from the perspective of a TUM student, an interview was conducted with Clemens Zengler, one of the leaders of the Environmental Department of the Student Council at TUM.

A research group of eight TUM students found out that online lectures consume less energy than those on-site. The figure shows this result for a scenario with 450 students joining a lecture.

A lecture with 450 students consumes:
Total consumption · On-site · Online

Clemens is doing his Master's Degree in Mechanical Engineering at TUM and studying at the Munich School of Philosophy. Since 2019, he has been a member of the Environmental De-partment of the Student Council at TUM. Here, he works to increase awareness of the environment and sustainability at TUM. In 2021, he took over the leadership of the department.

During his studies, he spent a semester abroad in Sweden to learn more about the way Swedish society tackles sustainability. In his free time, he likes to go running and hiking.

How did you experience it when all lectures were suddenly held online due to the Corona pandemic?
In the beginning, it was quite nice because I had a lot of time to do sports or meet friends from nearby. But I also noticed that I didn't follow the lectures very well. I was like, "oh, it's like a podcast in the morning," you know? I got very easily distracted and was often doing something else parallel to the lectures.

In the long term, what impact did online teaching have on your social life and mental health?
It definitely affected my social life because the pandemic started at the beginning of my master's program. So, I didn't have the chance to meet any new students. This, of course, had effects on the way I study and my interest in studying. Now, after two years of pandemic and only online lectures, I just recognized that I'm not that motivated anymore in studying. This is something I also recognized in my mental health. I feel very exhausted by all the studying.
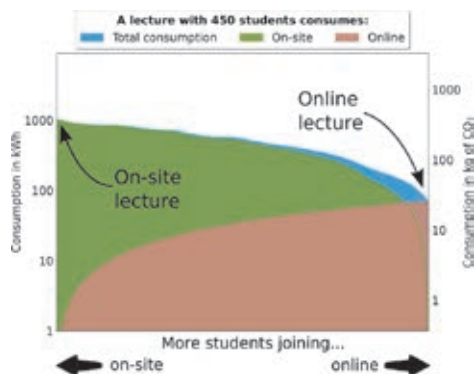
In general, which lecture type do you prefer? Why?
When we're talking about just one specific type, I would definitely say live lectures. From my experience, the lecture material is better presented on-site, possibly because many lecturers are not very experienced in online lectures. But in terms of an entire study program, I would prefer a hybrid format, where I can also choose online lectures.

What role does sustainability and climate protection in general play in your life?
Sustainability is one of the major components of my life since climate change is one of the biggest problems humanity faces in this century. This is something which makes me very enthusiastic on one side, but also very depressed on the other side. I want to contribute to a solution to this problem as far as possible, but I'm also very afraid of the consequences of climate change.

What do you do to be part of the solution to climate change?
Firstly, I'm part of the Environmental Department of the Student Council at TUM. There, we try to represent the students' opinions on sustainability and to foster sustainable development by raising awareness. Secondly, in my mechanical engineering studies, I focus on energy systems and more specifically fluid mechanics. I try to focus on wind energy because I think that we need more sustainable energy sources.

Were you surprised by the results of our research?
I was very surprised. I was especially surprised by the amount of energy that live lectures consume. It is, from what I remember, 10 times higher than what online lectures require. That is such a huge difference.

What consequences do you draw from this for you personally? Does this change your preference for lecture type?
To be honest, this does not really change my lecture type preference because an essential part of studying is meeting other students. Without this, I could just do remote studies and that's not why I study. So, I would still go to live lectures because this social part is very important to me. I think that there are some parts in life, where you should try to reduce emissions, but we cannot stop everything that makes life good.

What about hybrid lectures?
I would go for the hybrid format to have a medium energy consumption.

Would you be willing to save energy and switch completely to online lectures as a climate protection measure?
No, since the purpose of being at the university is not only studying, but also networking and sharing new ideas with other people. Creativity, in particular, has suffered under online lectures, which led to a decline of good ideas. Better ideas come with attendance!

Moving away from the individual level, which consequences should the TUM Presidential Board draw from this insight?
They should draw the conclusion that a hybrid format is the best possibility for academic education. Therefore, the Presidential Board should advise the teaching staff to offer both options for as many lectures as possible.

The basis for this interview was our assumption that there is a dilemma between social activities of students and the high energy consumption of on-site lectures. After our discussion, what do you think? Does this dilemma exist?
That's a difficult question. In my opinion, this dilemma does not really exist. Apart from transportation, most of the energy consumption is accounted for by the university and the State of Bavaria. Therefore, TUM must think about which type of energy it consumes and how it can be reduced. Otherwise, the responsibility would be incorrectly shifted from TUM to the individual students.

Last but not least, do you think it is worth it to limit the students' social lives to save energy?
Definitely not! Studying is also there to socialize, discuss your future, and get inspired by other people. This does not happen, or barely happens, online. TUM itself is responsible for its energy consumption and should try to reduce it. This is not part of the students' tasks! ◼

elecTUM

Abstract

In this study, the energy consumption of online (streaming or video on demand) lectures is compared with on-site lectures. On-site lectures consume up to 2 orders of magnitude more energy than digital formats, making any combination of both always more energy intensive than purely online lectures. Transportation is the most energy consuming factor. In scenarios with a decreased impact of transportation, hybrid or purely on-site lectures can become more favorable in terms of energy consumption, especially if several on-site lectures are attended in one day.

1. Introduction

Since February 2020, the COVID-19 pandemic has not only changed societal life, but has also had a major impact on universities. Lectures and seminars, which were previously held almost exclusively on campus, were transformed into online events. In addition to far-reaching consequences for the social life of students and teachers, this also affected the energy consumption of lectures. As the production of energy often produces greenhouse gasses that are responsible for climate change and its negative consequences, their consumption should be as low as possible.

Due to its more than 45,000 students, the Technical University of Munich (TUM) holds a particularly large number of lectures. This gives rise to the responsibility of developing a teaching strategy that is as sustainable as possible by using as little energy as possible, given that Germany has not yet achieved an energy grid solely composed of renewable energy sources. In order to develop such a strategy, the question must be answered as to what extent the combination of online and on-site lectures can minimize the energy consumption of academic education.

By using energy consumption as the indicator of sustainability, the research question is limited to the environmental dimension of sustainability while neglecting the social and economic one. This perspective was chosen since energy consumption and its conversion in carbon dioxide emissions are clearly defined parameters for measuring the environmental dimension.

To answer the research question, the energy consumption of online and on-site lectures needs to be calculated separately. So far there are no known studies that discuss this issue. Therefore, no concrete examples existed on how to survey the energy consumption of lectures. To be able to calculate it, our own concept of categories of energy consumption was developed based on literature research. The data was acquired by on-site evaluation at the TUM campus, a survey conducted among TUM students and literature research.

From this, a model was created comparing the energy consumption of online and on-site lectures at TUM. A case study was then conducted in which various parameters of the TUM data were changed to illustrate their influence. The results of the study should assist the TUM Presidential Board to develop a sustainable academic education strategy after the COVID-19 pandemic.

2. Data

2.1 General considerations

The energy consumption of on-site and online lectures can be divided into different subgroups (Figure 1). In-person lectures require the students to travel to the university, which can be done individually, e.g. by car, or using public transport. During the lecture, the equipment of the lecture hall and the electronic devices of the students need to be considered. If lectures are attended online, the students' electronic devices, the equipment of the workroom and the action of streaming the lecture live or on demand have to be taken into account. Here, it is important to recognize that the electronic devices used might differ between online and on-site lectures. The energy consumption is given in kWh and can subsequently be calculated in equivalents of CO_2 emissions in kg using the conversion factor of the German power grid for 2020, $0.366\,kg\,CO_2/kWh$. (Icha, Lauf, and Kuhs 2021)

2.2 Data acquisition

To answer our research question, to what extent the combination of online and on-site lectures can minimize the energy consumption of academic education, the two scenarios – online versus on-
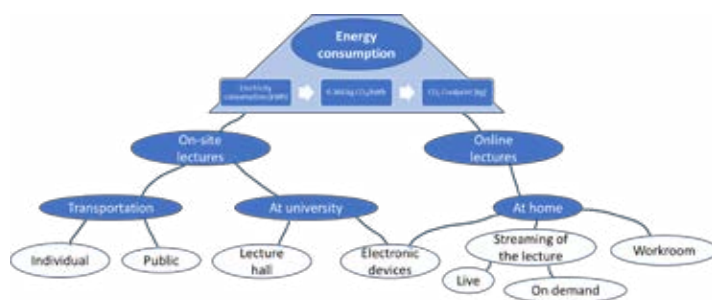
Figure 1: Categories of energy consumption of online and on-site lectures. The upper section shows the relation between the electricity consumption and the carbon dioxide footprint. Branched from the upper section, two different sources of energy consumption are defined: on-site and online lectures. For each lecture type, the factors contributing to its energy consumption are further specified.

site – have to be calculated first. As seen above in Figure 1, the calculation involves many variables, which are mostly determined by literature research. The electricity consumption of a typical lecture hall is researched by an on-site evaluation of the consuming devices, in which the light bulbs, beamers, and power supplies were counted. This on-site evaluation is combined with the inventory list cited below (See "At University"). The specific data of the students of TUM regarding transportation and electronic devices is investigated using a survey (see below) and our own measurements (see Supplementary Information, SI).

Transportation
Means of transport that are considered are car, motorcycle, bike, and on foot for individual and regional train, metro/municipal railway/tram, and bus for public transport. For car, motorcycle and bus, the energy consumption needs to be converted from kg CO_2 to kWh using the conversion factor from above [$1/0.366$ kWh/(kg CO_2)] for the use in the calculator. All values are listed in Table 1 SI and Table 2 SI. The travel time of the students is based on the survey.

At university
During an in-person lecture, the electricity consumption of the lecture hall and the electronic devices of the students and the lecturer are considered. Based on all lecture halls of the TUM (see Table 3 SI), the "Hörsaal 1, Interims II" (see Figure 1 SI) was chosen as representative for a modern, medium sized lecture hall with 449 seats. For comparison, lecture halls with less than 100 seats are defined as small, whereas halls with more than 500 seats are defined as large in this work. A list with the inventory and electricity uptake of the lecture hall's infrastructure can be found in Table 4 SI. Some students are expected to use electronic devices during the lecture. How many actually use them and what kind of device is queried in the survey. Electronic devices considered for on-site lectures are smartphones, tablets/iPads, laptops. The electricity uptake of these devices is listed in Table 5 SI.

At home
If the lecture is attended online, the electricity uptake of the used electronic device, the equipment of the student's workroom and the data transmission via the internet are considered. In this scenario, desktop PCs and additional screens are included in addition to the other devices. Based on a request to the student housing administration, a typical workroom has a LED lighting bulb with 13 W. For the internet connection and usage, a router, access and the infrastructure (core network; in the case of video on demand: data centers) are electricity consuming segments (see Table 6 SI).

2.3 Survey
The implementation of the calculator required, among other things, the collection of specific behavioral data from TUM students. This included information on transportation, electronic device use, and average streaming hours. To obtain this information, a survey was established. Given that the questionnaire was to be used to create the calculator, accurate data collection was required, while simultaneously keeping it simple and short, to increase the number of participants. The preliminary draft of the survey was created in August 2021, and a month later, after many rounds of feedback with the group members and supervisors, the final version was

determined. In the first week of October, the survey was launched on the platform "evasys".

The survey consisted of six parts:
i. Personal information (questions about age, semester, course of study).
ii. Transportation – before the pandemic
iii. Transportation – on-site lectures (expected transportation when on-site lectures are reintroduced)
iv. Lectures, courses, semester (number of attended lectures, number and types of devices used)
v. Living situation
vi. Satisfaction and well-being

The questions from (i) to (v) were used as part of the calculator's database. The questions from (vi) served as an interesting source of information for the qualitative evaluation of the students' satisfaction with their experience of university during the pandemic as compared to before.

Prior to its usage in the calculator, the survey data was post-processed in an effort to cast it into a form accepted by our model (see section 3). Here, several simplifying assumptions were made:

■ **Faculties**: The study programs indicated by the survey participants were binned under the corresponding faculty name in order to structure them into larger groups. Hereby, the bins were chosen so that similar study programs (in terms of lecture style) could be grouped into faculties (e.g. Mechanical Engineering and Aerospace Engineering). Very specific study programs with few participants were equally grouped together.

■ **Transportation**: Students were only assigned one means of transport. Students using multiple means of transport were assumed to use only the most expensive one, energy wise, unless they were traveling to the university exclusively by bike or on foot. In this case, students were assumed to travel only by bike (if used) or by foot. The travel time remains unmodified.

■ **Device types**: Here, a similar strategy to the transportation was applied, i.e. students were always assumed to use only the most expensive device, energy wise. Additionally, during on-site lectures (i.e. answers about the used device types before the pandemic), students were assumed not to use a desktop PC or any additional monitor. Moreover, during online lectures (i.e. answers about the used device types during the pandemic), additional monitors were only allowed in conjunction with either a desktop PC, a laptop or a tablet.

Acquiring participants was particularly challenging, especially since new COVID-measures were introduced during the conduct of the survey, which reduced the effectiveness of some forms of advertisement. Many different methods with their respective design layouts were used to spread the word about our survey, including:
■ Publishing on our website;
■ Outreach to the student councils of the various departments;
■ Posts on Instagram, notably on the accounts of TUM: Junge Akademie and the environmental department (Umweltreferat) of TUM;
■ Slides with the survey in the student union cafeteria;
■ Posters;
■ Sharing within our circle of friends;
■ Publicity through and appearance in online lectures; and
■ Newsletter of TUMJA.

The survey was officially closed in the first week of December with a total of 224 participants.
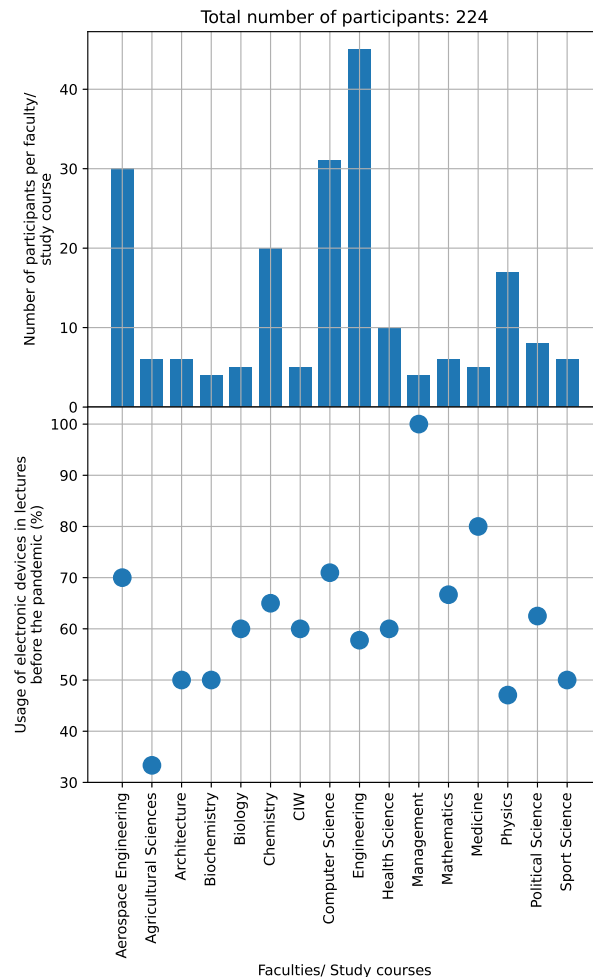
Figure 2 illustrates the participation in the survey across the different (binned) faculties, as well as the usage of electronic devices before the pandemic, i.e. the value used for on-site lectures. Table 1 also shows some averaged results obtained from the survey. It should be stated that these are only for illustrative purposes and do not represent the data used in the following calculations. Here the full statistical data obtained from the survey was utilized.

Lectures per day [a)]	2.7
Most used device type during on-site lectures [a)]	Laptop
Most used device type during online lectures [a)]	Laptop (+ additional screen)
Average travel time to university (min)	53
Most used means of transport	Subway

Table 1: Important averaged results obtained from the survey. These are only for illustrative purposes and do not actually represent the data used in the following calculations. [a)] Value for the Faculty of Mechanical Engineering, see section 4.

3. Methods

In this section, the general approach to calculating the consumption of lectures, both online and on-site will be discussed in detail. This approach is implemented in the ELECCALC toolkit,[1] which is under active development.[2] The discussion will be split into two main parts, one for the calculation of on-site lectures and one for online lectures. Both of them combined then constitute the hybrid scenario.

3.1 On-site lectures

The power consumption of on-site lectures $W_{\text{on-site}}$ is given by

where W_{LH} describes the consumption of the used lecture hall, W_{T}

$$W_{\text{on-site}}(n_{\text{S}}) = W_{\text{LH}} + W_{\text{T}}(n_{\text{S}}) + W_{\text{D,off}}(n_{\text{S}}), \quad (1)$$

the consumption caused by transportation to the lecture hall and $W_{\text{D,off}}$ the consumption of all electronic devices used during the on-site lecture. n_{S} is the number of students participating in the lecture. These different contributions can then be broken down further:

1 Available under https://electum.ja.tum.de/
2 https://github.com/AlexHls/ElecCalc

The lecture hall consumption W_{LH} consists of a base consumption, accounting for
- Blackboard lights
- Stair lights
- Amplifiers
- Microphones
- Cameras
- Other, lecture hall specific contributions.

If so specified by the user, beamers will be added to this base consumption if available for the respective lecture hall.

The consumption due to transportation W_{T} is given by

$$W_{\text{T}} = \sum_{n_{\text{S}}} \frac{2 \cdot W_{\text{MoT}}}{n_{\text{lpd}}}, \qquad (2)$$

where W_{MoT} is the consumption of any given means of transport (MoT), e.g. a bus, which in turn is given by

$$W_{\text{MoT}} = \begin{cases} P_{\text{T}} \cdot d_t \cdot t_{\text{travel}}, \\ m_{\text{CO}_2} \cdot f \cdot d_t \cdot t_{\text{travel}} \end{cases} \qquad (3)$$

depending on whether the energy consumption per km, P_{T} or the produced amount of CO_2 (m_{CO2}, which is converted into $W\,km^{-1}$ by a conversion factor f) is known. Furthermore t_{travel} the travel time in minutes, which is converted by d_t into kilometers traveled. Lastly, in eq. (2), the consumption of the individual MoT is then multiplied by 2 to account for the travel to and from the university and scaled by the number of lectures per day n_{lpd} to only account for the contribution to the specific lecture under investigation.

To establish which MoT is used by the students as well as the respective travel time, the survey data described in section 2 is used to get a multidimensional Gaussian kernel density estimate (KDE) using SCIPY (Virtanen et al. 2020). Here the bandwidth is selected using Scott's Rule (Scott 2015). This KDE is then used as a likelihood function to re-sample the survey to the number of students taking part in the lecture. The sampling is done using EMCEE, a pure-Python implementation of Goodman & Weare's Affine Invariant Markov chain Monte Carlo (MCMC) Ensemble sampler (Foreman-Mackey et al. 2013), whereby every student is assigned one walker. After the sampling, the result is averaged over several samples.

The last term in eq. (1), $W_{\text{D,off}}$ is given by

$$W_{\text{D,off}} = t_{\text{lec}} \sum_{n_{\text{S}} \cdot u} P_{\text{D}}, \qquad (4)$$

where t_{lec} is the lecture duration and P_{D} is the power draw of a given device, e.g. a laptop. Here, the number of students is modified by a percentage u which specifies the fraction of students using electronic devices during on-site lectures, as specified by the survey described in section 2. Similarly to eq. [eq:transp], the used devices for each student are sampled from a KDE using EMCEE.

3.2 Online lectures
Online lectures are calculated similarly to on-site lectures described in section 3.1: Their consumption is given by

$$W_{\text{online}}(n_{\text{S}}) = W_{\text{LS}}(n_{\text{S}}) + W_{\text{L}}(n_{\text{S}}) + W_{\text{D,on}}(n_{\text{S}}). \qquad (5)$$

Here, W_{LS} describes the consumption of the lecture service (i.e. either a streaming or VoD service), W_{L} the consumption of the accommodation of the students and $W_{\text{D,on}}$ the consumption of the devices used to join the online lecture. Again, these contributions can be broken down further:

The lecture service contribution W_{LS} is composed by

$$W_{\text{LS}}(n_{\text{S}}) = n_{\text{S}} t_{\text{lec}} \cdot \begin{cases} P_{\text{access}}^{\text{VoD}} + P_{\text{router}}^{\text{VoD}} + P_{\text{core network}}^{\text{VoD}} + P_{\text{data center}}^{\text{VoD}}, \\ P_{\text{access}}^{\text{Streaming}} + P_{\text{router}}^{\text{Streaming}} + P_{\text{core network}}^{\text{VoD}}, \end{cases} \qquad (6)$$

containing access, router and core network power, and in case of VoD services, also the data center power.

The energy consumption due to the accommodation of the students W_{L} is described by

$$W_{\text{L}}(n_{\text{S}}) = n_{\text{S}} \cdot t_{\text{lec}} \cdot n_{\text{light}} \cdot P_{\text{light}}, \qquad (7)$$

considering the number of lights n_{light} with a power draw of P_{light} at the study area of the students.

Last but not least, the power consumption of the used electronic devices $W_{D,on}$ is given analogously to eq. (4):

$$W_{D,off} = t_{lec} \sum_{n_S} P_D, \qquad (8)$$

the main difference being that the summation runs over all students.

3.3 Hybrid lectures

Hybrid lectures are calculated as a combination of an on-site and an online lecture, whereby the consumption of each sub-lecture is calculated as described in section 3.1 and 3.2, respectively. This means that the total consumption of a hybrid lecture is given by

$$W_{hybrid}(n_S, n_{onsite}) = W_{on\text{-}site}(n_{onsite}) + W_{online}(n_S - n_{onsite}), \qquad (9)$$

with n_{onsite} being the number of students joining the lecture on-site

4. Results

4.1 Consumption of the TUM Garching campus

In this section, the results obtained with the data gathered for TUM as described in section 2 are presented, using our calculator detailed in section 3. Here, only the Faculty of Mechanical Engineering is considered, since the most data is available for this faculty and we can thus rely on a better statistic for the sampling procedure. Our investigations found that using other faculties does not yield significantly different results, but is connected to much larger statistical uncertainties and will thus not be discussed further. Figure 3 shows the results obtained for both a hybrid-streaming and a hybrid-VoD (video-on-demand) lecture, either with 450 students (i.e. in cases where the lecture hall is at full capacity) or 30 students. Throughout this work, it is assumed that the duration of a lecture is 90 minutes. What immediately stands out is the fact that the total consumption is dominated by the transportation, and it is only in cases where very few students join on-site that it becomes negligible. This leads to the result that an on-site lecture is never the favored lecture mode from an energy consumption perspective, as the consumption of the transportation surpasses all other contributions by up to two orders of magnitude, based on the data collected in our survey. In contrast, when considering all contribu-

tions except transportation, a pure on-site lecture is favored. This means that the on-site lecture is made unfavorable purely by the contribution of the transportation.

Regarding all other contributions, most of them behave as expected and scale linearly with the number of students (e.g. the living costs or streaming/ VoD service) or are constant in case of the lecture hall. The only deviation from this behavior is in the case of the electronic devices, which is caused by the fact that students tend to use electronic devices in both online and on-site lectures, but to varying degrees (e.g. by connecting to a second monitor or using a desktop PC during online lectures). Nonetheless, the consumption caused by the device usage increases the more students join the lecture online and it becomes the dominating contribution for lectures where the majority joins online.

Furthermore, it should be pointed out that, in cases where the lecture hall is used (in a full on-site scenario), the consumption of the lecture hall is rather minor and is overshadowed by the consumption of the electronic devices. This drastically changes if the lecture hall is severely under-used (see the lower row of Figure 3). In such cases, the lecture hall is the driving factor of the on-site consumption, since it is designed for 450 students.

Last but not least, it should be highlighted that in our data, the VoD online lecture consumes more energy than a streamed online lecture, due to the storage of the videos in data centers. Yet, since the difference does not change the overall tendencies of the result, the focus will be on the streaming mode for the remainder of this section. The VoD lecture also seems to be less suited for a "simultaneous hybrid lecture" and is further complicated by the fact that a VoD might be watched several times, adding further uncertainties.
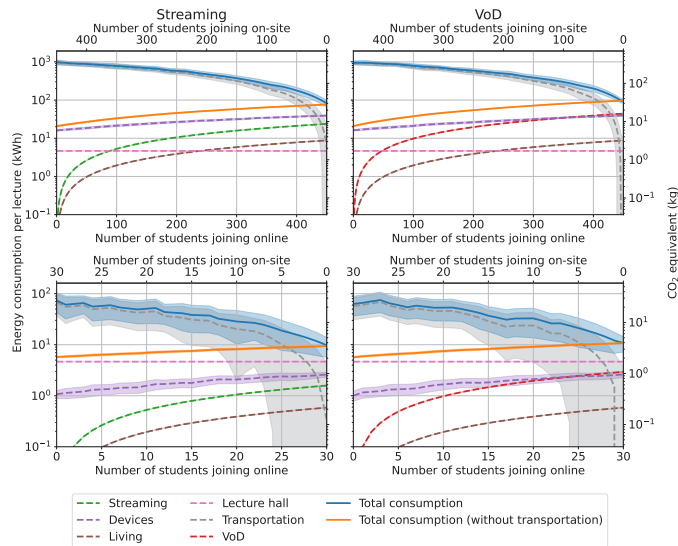
Figure 3: Results obtained with our TUM data. The upper row shows a hybrid-streaming and – VoD (video-on-demand) lecture with 450 students, the lower row the same scenarios with only 30 students. The shaded regions indicate the 1σ statistical uncertainty region originating from the sampling procedure described in section 3. The kinks in some of the curves are an artifact of the statistical sampling.

Figure 4: Comparison of different means of transport scenarios. The shown scenarios are either the means of travel as established by our survey (TUM statistic), all students going by car or motorcycle (Individual transport), all students not arriving by bike or on foot using public transport (Public transport) or 90% of students arriving by bike or on foot with the remaining 10% traveling 15 minutes by bus on average (Localized campus). The individual contributions to the total consumption are identical to Figure 3 and not shown for clarity. The shaded regions indicate the 1σ uncertainty region originating from the statistical sampling described in section 3.

4.2 Case studies based on the TUM data
In this section, several case studies are presented where specific areas of the TUM data are modified to illustrate the effect of changes of, e.g., the traveling behavior of students.

4.2.1 Individual transport vs. public transport vs. localized campus
The first case study focuses on the effect of different means of travel on the total consumption. Here, three different cases are compared to the original TUM data illustrated in Figure 3: The "**Individual transport**" scenario assumes that students would travel by car or motorcycle (equally split), whereby the travel time is randomly drawn from a normal distribution with a mean and standard deviation equal to the values of the car and motorcycle users from our survey. Similarly, in the "**Public transport**" scenario, all students not already arriving by using the subway or bus (or on foot/

by bike), are now represented as using the subway with their travel time randomly drawn from a normal distribution around the travel time of the subway users from our survey. Lastly, a scenario is considered where all students live within walking or cycling distance of the campus, and only 10% of students are using the bus ("**Localized campus**"). Their travel time is normal distributed with a mean of 15 minutes and a standard deviation of 5 minutes.

The results of this case study are illustrated in Figure 4, together with our TUM data for comparison. It becomes immediately evident that individual transport is in no way a desirable outcome as it increases the energy consumption by another order of magnitude. In contrast, when students use public transport, this would drastically reduce the consumption, but not yet to a degree where on-site lectures consume less energy than online lectures. This is

due to the rather long travel times found at TUM (see section 4.2.2 for more details). If now a campus is considered where most students can go to their lectures on foot or by bike, the transportation consumption becomes, as expected, small enough to be no longer a driving contribution, which leads to the fact that on-site lectures become the cheaper option. In this case, the total consumption is again dominated by electronic devices.

4.2.2 Influence of travel time
Following the insights gained in section 4.2, the influence of different travel times on the total consumption is investigated. Here, the case study is based on the "**Public transportation**" scenario from the previous section, i.e. all students using public transportation, in an effort to explore further options on how to make on-site lectures at TUM consume less energy. The travel time of all students using public transport is systematically decreased by replacing their travel time by a random time drawn from a normal distribution around 5, 10 or 20 minutes, with a standard deviation of 5 minutes for the mean of 5 minutes or 10 minutes for the other two cases. For comparison: the average travel time in the "**Public transportation**" scenario is around 49 minutes, which is roughly the same as for our TUM data with an average of around 52 minutes. The resulting consumptions are illustrated in Figure 5.

The takeaway from this study is that, in an effort to significantly reduce the contribution of the transportation in a TUM-like means of travel distribution, the travel time has to be cut down significantly to make an on-site lecture consume less energy than an online lecture. In our calculation, this would mean that students need to travel on average at most 5 minutes – even if exclusively using public transport –, which effectively means that the campus should be located, e.g., within only a few stations of the subway. Nonetheless, even for such reduced travel times and public transport only, the transportation consumption is still the dominating contribution for full on-site lectures.

4.2.3 Device usage and lectures per day
In the last case study, the influence of the device usage during on-site lectures and the effect of the number of lectures per day is investigated. Here, the "**Public transportation**" scenario from

section 4.2 is again taken as a baseline, but the device usage is modified during on-site lectures, i.e. set to 0, down from the original 75%. This scenario is then further modified by increasing the lectures per day up from 2.7 (i.e. the value used in the previous sections) to 5 or 10. The results can be seen in Figure 6.

Although not using devices in on-site lectures drastically reduces the consumption before considering transportation, it has little effect on the total consumption. If students do, however, take more lectures (or, e.g., tutorials for that matter) per day, the contribution of the transportation to a single lecture can be again reduced. In our model, students would need to travel for around 10 lectures (15 h lectures non-stop!) to the campus, to effectively make the on-site lectures more favorable in terms of energy consumption than the online lectures. In summary, while not using electronic devices in lectures has little effect on the total consumption, traveling to the campus for as many lectures as possible can have a much more beneficial effect on the total consumption.
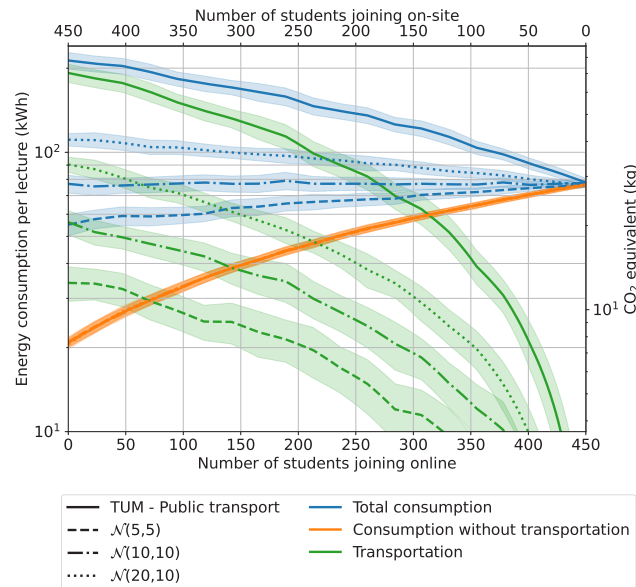
5. Discussion

Figure 5: Comparison of different travel distances scenarios. The shown scenarios are based on the "Public transport" scenario shown in Figure 4. Here, this scenario has been modified by varying the average travel time of students using public transport, whereby the travel time is drawn from a normal distribution $\mathcal{N}(\mu,\sigma)$ with the indicated properties. The shaded regions indicate the 1σ uncertainty region originating from the statistical sampling described in section 3.

5.1 Student satisfaction and well-being

The last section of our survey assessed five more subjective changes in student life during the pandemic, namely in productivity, social life, liking of university, grades and mental health.

Productivity decreased in over half (52.3%) of people, stayed the same for around one quarter (22.3%) and increased for another quarter (25.4%), resulting in a slight decrease on average (Av 2.6, Med 2). This may be explained by more distractions in the home environment, such as electronic devices leading to procrastination, more free time and therefore less time sensitivity and possibly less accountability while working alone at home as compared to in groups with others.

Most students experienced a stark decrease in their social life during the pandemic, undoubtedly explained by the COVID-19 restrictions: almost three quarters (70.5%) of students stated that their social life got much worse or worse, while only 12.5% stated it improved (Av 2.2, Med 2).

When asked if they liked university more or less compared to before the pandemic, almost half (44.7%) chose "less" or "much less"; 37.5% said their feelings did not change, and only 17.9% declared liking it more. This slight decrease (Av 2.6, Med 3) could be explained by less interactive lecture formats, fewer internships and seminars and likely by less contact with other students, a crucial part of university life.
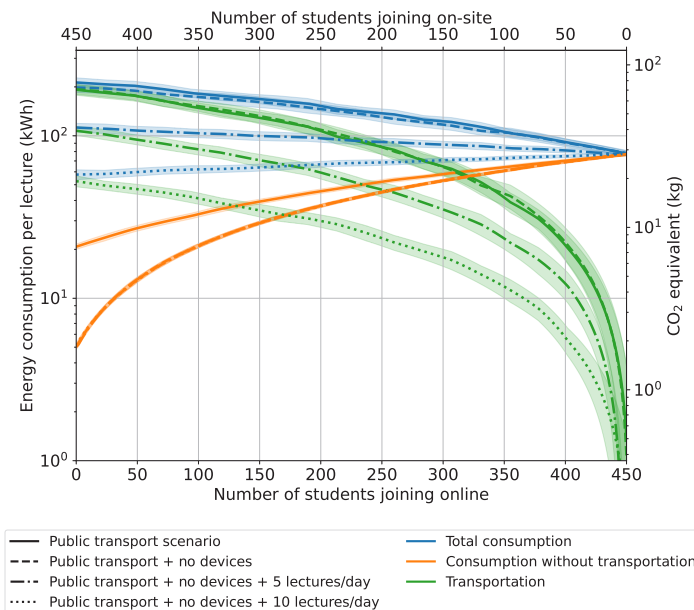
Figure 6: Investigation of different device usages and lectures per day. Here several scenarios are compared in which students do not use any electronic devices during on-site lectures with the "Public transportation" scenario from Figure 4. Additionally, in two scenarios, the lectures per day are increased compared to the value established by our survey. The shaded regions indicate the 1σ uncertainty region originating from the statistical sampling described in section 3.

Interestingly, the grades of most (53.6%) students stayed the same (Av 3, Med 3). Only very few got much better or much worse grades. This lack of change, despite a decreased productivity and liking of university, might be explained by two factors: more time to study – there was no commuting and less social life – and possibly easier exams, as many lecturers were aware of the difficult situation and were trying to not make student life even harder. Finally, and as one would expect, the mental health of students got worse during the pandemic (Av 2.5, Med. 2). While around one third (35.7%) of students saw no change in their mental health, over half (52.2%) of students saw a decline, with 38.8% and 13.4% stating that it got worse or much worse, respectively. Only 12.1% experienced their mental health improving. Although this might well be linked to the university experience of our participants, the general context has to be considered here. Undoubtedly, these unprecedented and highly challenging times have had a negative impact on students' mental health as well.

To further analyze the data, we looked into the interrelationships between different answers and created a correlation matrix (see Figure 7) based on Peason's correlation coefficient (Pearson 1895) (blue = negative correlation, red = positive correlation).

It is clear that all five of these subjective changes (5 SC) are strongly positively correlated, meaning that students generally either suffered in all areas or weren't so affected in all of them. For example, those who liked university less also saw a greater decline in productivity, or those whose social life didn't decrease also suffered less mentally.

Positive correlations were found for age and the 5 SC, meaning younger students suffered more from the changed conditions in the pandemic. This might be due to the fact that older students already had ties to teachers and fellow students, while younger ones often only started university in COVID-times and therefore didn't have those connections. No strong correlations were found between the 5 SG and gender, and perhaps more interestingly, between the 5 SC and the students' living situation. One might have expected students living alone to be more affected than those living with friends or family, but that didn't seem to be the case.

Those living alone did seem to require fewer lectures per day in order to make it seem worth the travel to university.

Perhaps not surprisingly, students with a lower satisfaction and well-being during the pandemic tended to wish for more on-site lectures in the future, and seemed to think they required less energy as compared to online lectures. Whether the perceived lower energy cost led to the preference for on-site lectures, or this preference biased the energy estimation, we cannot say.

Besides general limitations of the study, this section is especially affected by the fact that many participants were not yet students at the beginning of the pandemic, therefore possibly distorting the changes in these factors. Furthermore, as mentioned above, these parameters are also more subjective than others and therefore have to be handled more carefully.

5.2 Economic aspects

To assess the advantages and disadvantages of online lectures for students, not only the subjective student satisfaction and mental health should be considered besides the energy consumption of lectures. The person and/or institution responsible for covering the expenses linked to the different lecture formats must also be taken into consideration. To do so, the different sources of such expenses must be delimited. Here, three main sources can be considered: material, energy consumption at the lecture site, and transportation.

Material, as a source of expenses, refers to the materials needed during lectures. While, for on-site lectures, only a notebook, a pen, and perhaps a lecture script are needed, an electronic device belongs to the minimum required for online lectures. Thus, only regarding the unavoidable materials, it is evident that, with electronic devices being more expensive than the non-electronic goods, students have to bear higher expenses for online lectures. Further, considering that the majority of students also use electronic devices during on-site lectures (62.1% always, 15.2% sometimes), the existence of these avoidable devices in on-site lectures must also be taken into consideration. However, even considering this existence, students still have higher expenses during online lectures.

Besides causing an increase from 62.1 to 100% in the percentage of students who always use electronic devices during their lectures, a switch from on-site to online lectures is also responsible for the addition of an additional screen to the electronic devices used (for 34.4% of the surveyed students).

As the second source of expenses considered, the energy consumption at the lecture site refers to the infrastructure expenses, such as lighting, and the expenses connected to the use of electronic devices. The infrastructure expenses are covered by the university during on-site lectures and by the students or their families during online lectures. Thus, through the shift from on-site to online lectures, the infrastructure expenses are taken away from the university. Since the percentage of students living with their families decreased during the pandemic (from 43.8 to 30.4%), it can be assumed that the infrastructure expenses are mostly directly transferred from the university to the students. Regarding the expenses connected to the use of electronic devices, three points must be considered. First, since the mobile electronic devices can be charged during on-site lectures, the costs referring to the energy consumed for charging the personal electronic devices do not only rely on the students. During online lectures, however, these costs rely on the students, hence increasing their personal expenses at home. Second, as previously discussed, online lectures are responsible for an increase in the number of electronic devices used, thus also increasing the energy consumed in the students' homes. Third, during online lectures, more powerful devices such as desktop-PCs also come into use, which also increase the energy consumed at home. Consequently, not only are the expenses regarding the infrastructure and the powering of devices shifted from the university to the students during online lectures, but the expenses regarding the powering of devices are also increased in this lecture format.

The last source of expenses considered, the transportation, is less straight-forward than the sources previously discussed. Since the most used means of transport among students refer to local public transport, the following discussion is based on this type of transportation. In Munich, university students, including those of TUM, have the opportunity to buy a ticket for over 200 Euros, with which
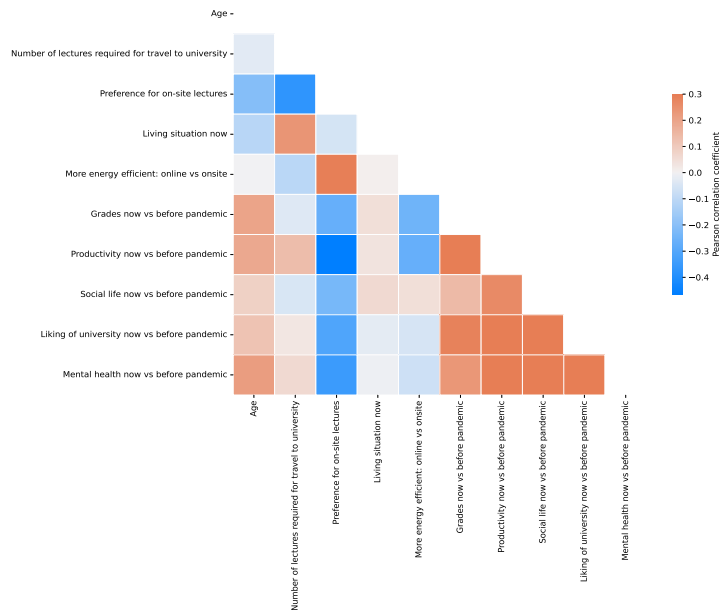
Figure 7: Correlation heatmap of selected survey results, as measured by Peason's correlation coefficient. Positive correlations in red, negative correlations in blue. Darker colors indicate a stronger correlation.

they can travel freely with local public transport during the current semester[3]. In a scenario in which the lectures happen solely online, one can argue that this ticket is not necessary, hence helping students save over 200 Euros per semester. However, in a non-pandemic state, it most likely would still be interesting to buy such a ticket from a financial point of view since traveling to and from social events, for instance, would still be needed. Hence, with this assumption, there would not be a saving from on-site to online lectures. Since the willingness to buy the mentioned ticket was not a question included in the conducted survey, this assumption cannot be confirmed.

3 https://www.mvv-muenchen.de/en/tickets-and-fares/frequent-travellers/
   mvv-semesterticket/index.html, last accessed 12.03.2022

In conclusion, even though online lectures are responsible for a lower energy consumption, several student expenses are higher in this lecture format. Besides the greater need for (more) electronic devices, online lectures are responsible for the use of electronic devices with more power and for shifting the infrastructure expenses from the university to the students. From a transportation point of view, the effect of the lecture format on the adherence to the explained semester ticket is unclear. To assess this adherence and, with that, the effect of the lecture format on the transportation expenses, an extra survey on this topic would need to be conducted.

5.3 Discussion of the case studies
Transportation appears to be the major contributing part to the energy consumption of on-site lectures in the case of TUM Garching, making on-site lectures in any case worse in comparison to online lectures in terms of energy consumption. The reasons for that can be found in the location of the campus: TUM Garching is situated around 13 km away from the city center of Munich (see Figure 2 SI). In addition, only a few dormitories are available in its proximity. The high living costs in Munich lead to some students not being able to live in the city but rather hvaing to commute to the university from the suburbs. Combined, these factors result in long travel distances, with the commuting time of the average student being around 50 minutes. Furthermore, even though only 12% of travel is done individually, its impact on the total energy consumption is vastly higher (car: ~22 fold; motorbike: ~13 fold consumption as compared to public transport per person). If all students came individually, this would even lead to the energy consumption being one order of magnitude higher.

However, a campus located somewhere near the city center with a shorter travel time for the students still does not make a big difference – in fact, the travel time needs to be decreased down to 5 minutes with the students using exclusively public transport for the on-site lecture to be more favorable than the online lecture in terms of energy consumption. Alternatively, a "localized campus" similar to American campuses, with a vast majority arriving by foot or bike, and the rest by bus, would be a scenario where the same result can be achieved.

With this in mind, a realistic, energy saving mode of a lecture suitable for TUM Garching could involve a hybrid format where the students with a long travel time join the lecture online whereas students living in close proximity, i.e. up to 10 minutes of public transport, join on-site.

Another approach to minimize the energy consumption is to have more lectures scheduled per day and thus fewer days at university per week, to make the most use of the energy spent for transportation to the campus. While it is of course unrealistic to have 10 lectures a day, as calculated in section 4.2.3, 5 to 6 lectures should be possible to attend. In combination with a shorter travel time, this is also a doable way of reducing the consumed energy per on-site lecture.

Of course, both strategies require the appropriate lecture hall sizes for each course at close to maximum capacity in order to make the most of the constant energy consumption of the facility. Also, the students can actively contribute to reduce the consumed energy per lecture. If they only have one lecture scheduled on a day, it makes sense to join the lecture online – if offered – to save energy.

The university, in return, can advise the lecturers to offer a livestream of their lecture and promote public transportation, e.g. by building the respective infrastructure. In the long term, the construction of dormitories in proximity to the campus is one of the most effective ways to minimize the energy consumption of academic teaching.

5.4 Validity and transferability of the results
Even though solid research was conducted to gather the necessary data to use in the developed calculator, two main sources of error should be considered. First, only 224 TUM students answered the conducted survey. Considering that TUM had a total of 48296 enrolled students in the semester during which the survey was conducted[4], the number of answers might not be fully representative for the en-

4 https://www.tum.de/en/about-tum/our-university/facts-and-figures, last accessed 12.03.2022

tirety of TUM students. Second, even though the living situation and the age of the electronic devices of students were inquired into within the conducted survey, this data was not included in the calculations presented in section 4. The influence of the living situation was not used due to missing data on the energy consumption of different student accommodations found in the Studentenwerk München. The influence of the device age was left out since it causes two opposite effects. On one hand, older devices tend to be less energy-efficient than newer ones. On the other hand, with technological advances, newer devices often have more powerful components, such as video cards. Thus, the effect of age on the power of an electronic device cannot be clearly quantified. The missing considerations of the living situation and the age of the electronic devices, however, should not have a significant influence on the final results. Since the energy consumption of transportation is up to two orders of magnitude higher than the energy consumption of other consumption sources (see section 4.1), small changes in the energy consumption of the living situation infrastructure and of the electronic devices would not affect the shown trend that on-site lectures consume more energy than online lectures. Due to the magnitude of the transportation, a study with more participants would also hardly change this trend since, as described in section 5.3, the location of the TUM campus in Garching is prone to cause high commuting rates. Hence, even though there is a certain margin of error to be considered, the general trend found in this study should still be seen as valid.

Besides analyzing whether the results of the conducted study are valid for TUM and, more specifically, to its campus in Garching, the transferability of such results to other universities should also be investigated. Due to the long commuting distances to the studied campus, only other universities with long travel distances can be directly compared to the TUM campus in Garching. As seen in Section 4.2.2, the travel time can play a significant role when it comes to reducing the energy consumption of on-site lectures. Further, since the majority of students commute to the university using local public transport, the city of the university to be compared with TUM must have a solid public transportation infrastructure. At the same time, however, it should be considered that a percentage of TUM students also commute to the university by car. Section 4.2 shows that there is a notable difference between the TUM reality

and a scenario in which students would only commute using public transport. This difference should also be noted when transferring the results to other universities. Further, especially considering the influence of individual transportation, which has its energy consumption calculated based on the emission of CO_2-equivalents (See Section 2), the country of the analyzed university must have a power grid similar to the one found in Germany. Lastly, regarding the use of devices and the number of lectures per day, which are thematized in Section 4.2.3, the transferability of the TUM results to other universities can be directly assured. First, it was shown that the number (and type) of devices used barely influences the energy consumption of on-site lectures when the TUM-like transportation is taken into consideration. Second, no matter what university, one can imagine that students would hardly want to attend more than 5 lectures (7.5 hours) per day. Consequently, the energy consumption of on-site lectures would still be higher than that of online lectures for any analyzed university that is similar to the TUM campus in Garching in the other aspects discussed.

Based on the conducted case studies (Section 4.2), universities with other realities, e.g. with a localized campus, can also analyze the energy consumption trends of their lectures and follow the general suggestions made in Section 5.3 on how to conduct energy efficient lectures.

6. Conclusion and outlook

In this study, the energy consumption of online and on-site lectures is compared. To the best of our knowledge, this is the first study of its kind.

The used data is based on literature and a performed survey. An online calculator is created for the estimations in this study but is usable for other universities as well. Uncertainties in the results remain due to assumptions based on the available data, hence only trends and no absolute numbers are discussed in the study.

The lecture site is the TUM Garching campus, which is located somewhat outside of the city. Thus, the results are valid for remote campuses, but the described scenarios are also applicable for local campuses.

On-site lectures consume up to 2 orders of magnitude more energy than digital formats, making any combination of both always more energy intensive than purely online lectures. Transportation is the highest energy consuming factor. For more local campuses, i.e. with a decreased requirement of transportation, hybrid or purely on-site lectures can become more favorable in terms of energy consumption, especially if several on-site lectures are attended in one day.

Approaches towards more energy efficient lecture formats include the suggestion for students to join online if they do not live in close proximity to the university, to concentrate the lectures on as few days as possible, to operate the lecture halls at maximum capacity and to provide student housing in the surroundings of the university in the long term. However, in the discussion of efficient lecture formats, the cost factor for students and student satisfaction have to be considered.

The discussed trends in this study might give certain hints on the energy consumption in similar cases, e.g. when comparing online meetings versus on-site meetings. Here, the same factors will make one format more favorable in terms of energy.

In future studies, the energy consumption of online and on-site lectures will be compared with the focus on heating and air conditioning. It is unclear to what extent individual heating and air conditioning of the student apartments might increase the energy consumption of online lectures, making them unfavorable in cold or hot seasons.

Data availability statement
The raw data collected on the lecture hall, means of transportation and living situations of students is available in the supplementary information[5]. The survey data, both in a raw and post-processed format will be made available upon reasonable request.

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5 https://docs.google.com/document/d/
   1_MO0ayQa8yu1KAbHsCVwT2SGo8Jh4FO7Ub8xOteZEpQ/edit?usp=sharing

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Check out our supplementary information (SI)!

Try our calculator yourself!

Self-reflection

Our TUM: Junge Akademie journey started with the first Zoom meeting held in November 2020.

A team of eight students with a multi-disciplinary academic background and diverse cultural upbringing came together under the name of Team Climate. Most team members were decisive about joining the team from the start, even though we all are from different fields, including chemistry, physics, medicine, architecture, sustainability, and politics. Regardless of this diversity, the theme of climate was intriguing to all of us. Starting from the broad topic of climate, many brainstorming and discussion sessions took place before we decided on the impact of energy consumption of online and on-site classes as our chosen research topic. The idea stemmed from the impact of COVID-19 on our university life and from the new way of conducting courses. The main questions we wanted to tackle were whether studying from home helps reduce the energy consumption and carbon footprint of students and what is the optimal combination between online and on-site lectures to minimize the overall energy consumption of TUM lectures. Thus, our developed research question was: to what extent can the combination of online and on-site lectures minimize the energy consumption of academic education? Having developed a calculator tool and finalized our research, our current purpose is to provide TUM with our results, hence helping inform its decision on which lecture type to favor in terms of energy efficiency, especially during this critical phase of transitioning towards going back to "normal." Further, an option in our developed calculator tool allows students to calculate their own energy consumption.

In order to further develop the topic, we had brainstorming and discussion rounds with our supervisors when we reached important milestones and with mentors during the seminar weekends organized by the TUMJA office. These talks were very helpful to the team in narrowing down the topic and precisely defining our research question. After that, we divided the team into three subgroups: survey, data collection and calculator. This division of tasks proved productive. First, it allowed the sub-teams to focus on one direction of the topic. Second, it made the discussions and decisions to be taken within the sub-team easier, given the smaller number of team members. Hence, it was more effective to work in small subgroups

and check in with the entire team when a subgroup reached an important milestone than to conduct long discussions in our eight-students team.

During our TUMJA journey, we also faced some challenges. Given the size of the team and the different backgrounds of its team members, our brainstorming discussions were very interesting but also intense and time consuming. Thus, we came up with a meeting structure where we took turns to be the moderator, responsible for keeping the discussions from straying off topic, and a minute-taker to keep track of our decisions during the meeting. Further, we tried to limit our meetings to one hour and have a small vote at the end to assess the mood and productivity of the team during the meeting. This structure proved very helpful for us to keep on track and follow up with our planned agenda. Additionally, it gave the opportunity to each team member to experience running a meeting or taking minutes of meetings– certainly great skills to learn before beginning our careers.

In addition, the COVID-19 pandemic was a challenge for us, as it did not allow us to experience the TUM: Junge Akademie at its fullest. Previous classes had the opportunity to have regular face-to-face meetings and bonding activities so the bond among them was definitely stronger than in our class 2021. However, we tried to make the best of it. We planned some in-person meetups when the COVID situation permitted it, such as going for dinner together or hanging out over ice cream.

TUMJA is an exciting and a challenging experience at the same time. Given the freedom we had as a team, with the opportunity to choose and implement our own project, conflicts were bound to arise due to the substantial differences among team members. Through our experience as a team, we learned that the most fruitful way to deal with such conflicts is, firstly, to openly bring up and discuss issues with the whole team and the tutors as early as possible, as this avoids making the issue personal and helps with de-escalating the problem. Second, as we are in a volunteering environment, communicating one's expectations and degree of involvement is key to enable the other team members to manage their expectations and own workload. Along with this, it is very important to keep
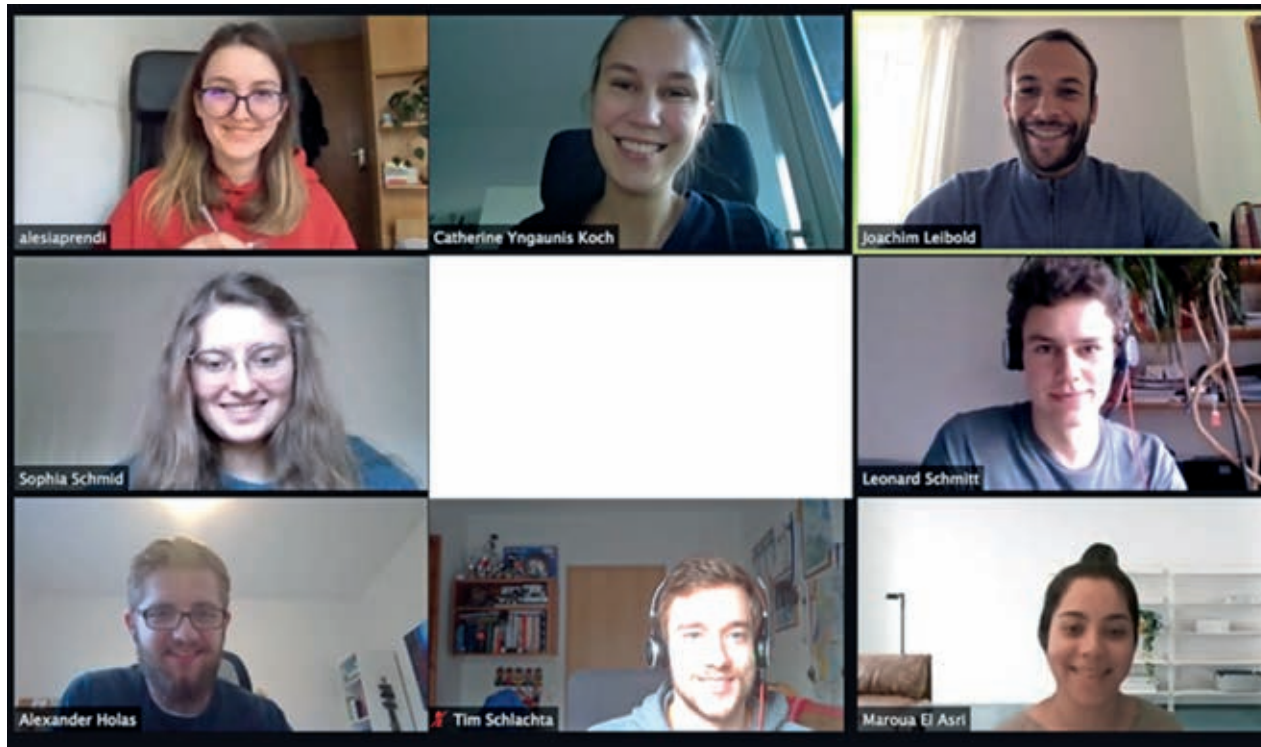
a respective tone at all times in order to avoid escalating the issue and making the matter personal. Lastly, the tutors and the TUMJA office are always available to help and provide constructive advice when they know about problems in the team early on.

Finally, we are grateful to our supervisors Prof. Dr. Sara Leonhardt and Prof. Dr. Peter Annighöfer for the great discussions, their feedback and for always helping us when we had any questions or needed contacts, for example to distribute our survey. We also want to thank Maryam Tatari and Sebastian Zäpfel, our tutors, who followed up with us since day one of our project and guided us when we needed it, especially towards the end of our project. We would like to thank our external collaborators and supporters who helped us

with brainstorming in an early stage of our project. Further, we would like to thank the Studentenwerk München and the facility management of the TUM Garching Campus for providing us with energy consumption related data of student dorms and lecture halls, respectively. Similarly, we appreciate the Sustainability Office at TUM, which provided valuable feedback about our project and the different TUM student organizations that helped us with distributing our survey. Also, we would like to express our sincere thanks to Peter Finger and the whole TUMJA team for their great commitment, which helped us in every situation to realize our project.

Team elecTUM
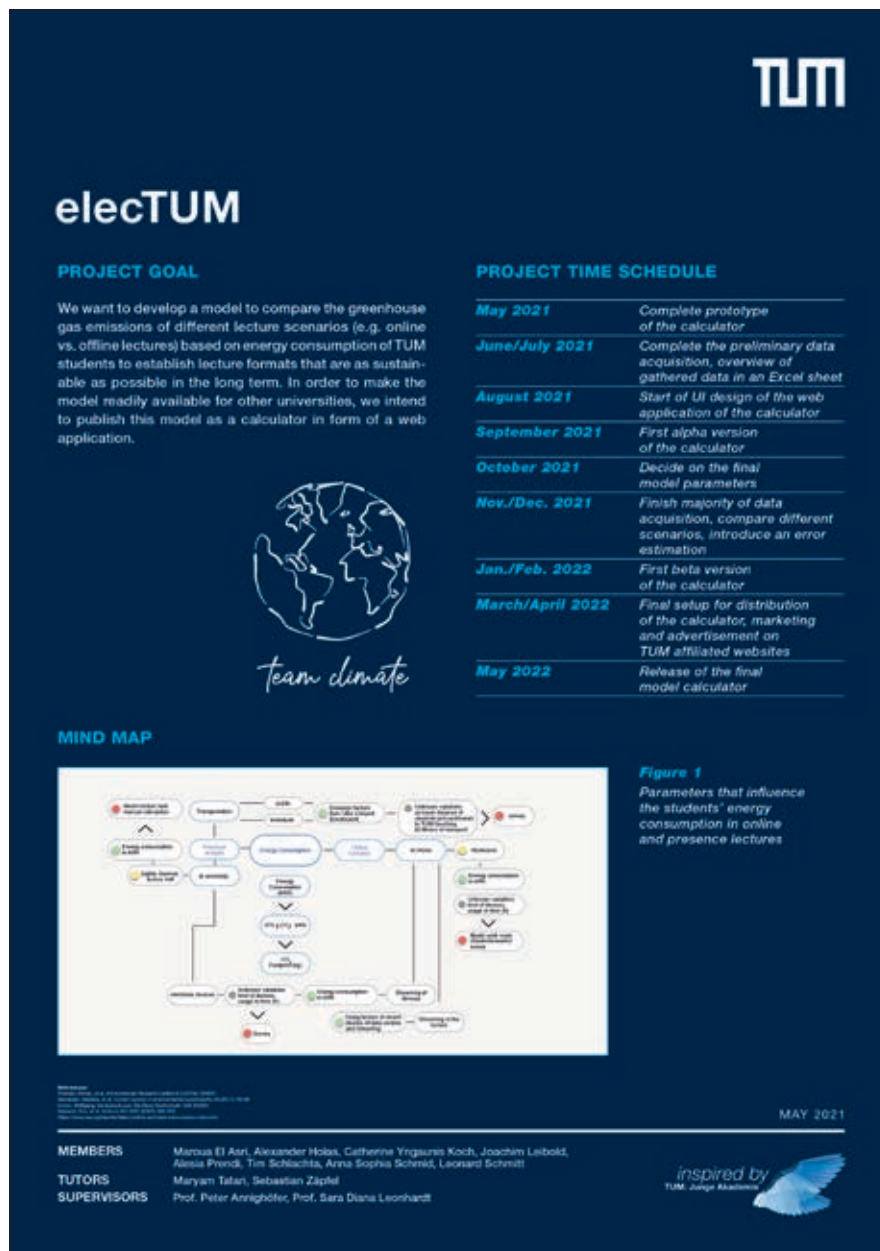
POSTER 1:

During our first scholarship months, we had several project management workshops in which we focused on defining a project goal and our time schedule. For the project goal, we first had to narrow down the topic of "climate" to a concrete subject that we could investigate. After long discussions, we decided to use the energy consumption of lectures to measure the impact of TUM students –and TUM in general – on the climate. Further, since we wanted to develop a project that would impact other universities as well, we included developing a web-based calculator in our project goal. This calculator could then be used by other universities and their students to assess the energy consumption of their own lectures. For the time schedule, we mainly focused on the steps that had to be completed regarding the development of the calculator and the acquisition of data, which would be inserted in the calculator for TUM-specific calculations. Lastly, after having achieved these project management milestones, we started brainstorming on the aspects that contribute to the energy consumption of students during online and/or in-person lectures. ■

POSTER 2:

During the time between posters #1 and #2, we continued working on our project management. To be more effective, we decided to divide our group into three sub-teams. The first was responsible for collecting necessary data for the TUM-specific calculations, such as the energy consumption of public transportation in Munich. The second was in charge of creating the survey, designed for collecting TUM-specific data on the students' behavior during lectures. Finally, the third focused on developing the web-based calculator. From this sub-team configuration, the first results started to emerge during this time: subgroup one was able to collect information regarding the energy consumption of a typical lecture hall at TUM and a typical student dorm from the Studentenwerk; the second subgroup completed a preliminary version of the survey; and sub-team three started implementing a database that would be later integrated in the web-based calculator.

Shifting from project management and our general progress, we also developed our research question during the time between posters #1 and #2. With the question "To what extent can a hybrid format between online and on-site lectures minimize the energy consumption of academic education?", we were able to narrow down the climate question to energy consumption, to include all forms of academic education, and to ask about the possibility of having a hybrid lecture format as the optimum scenario.
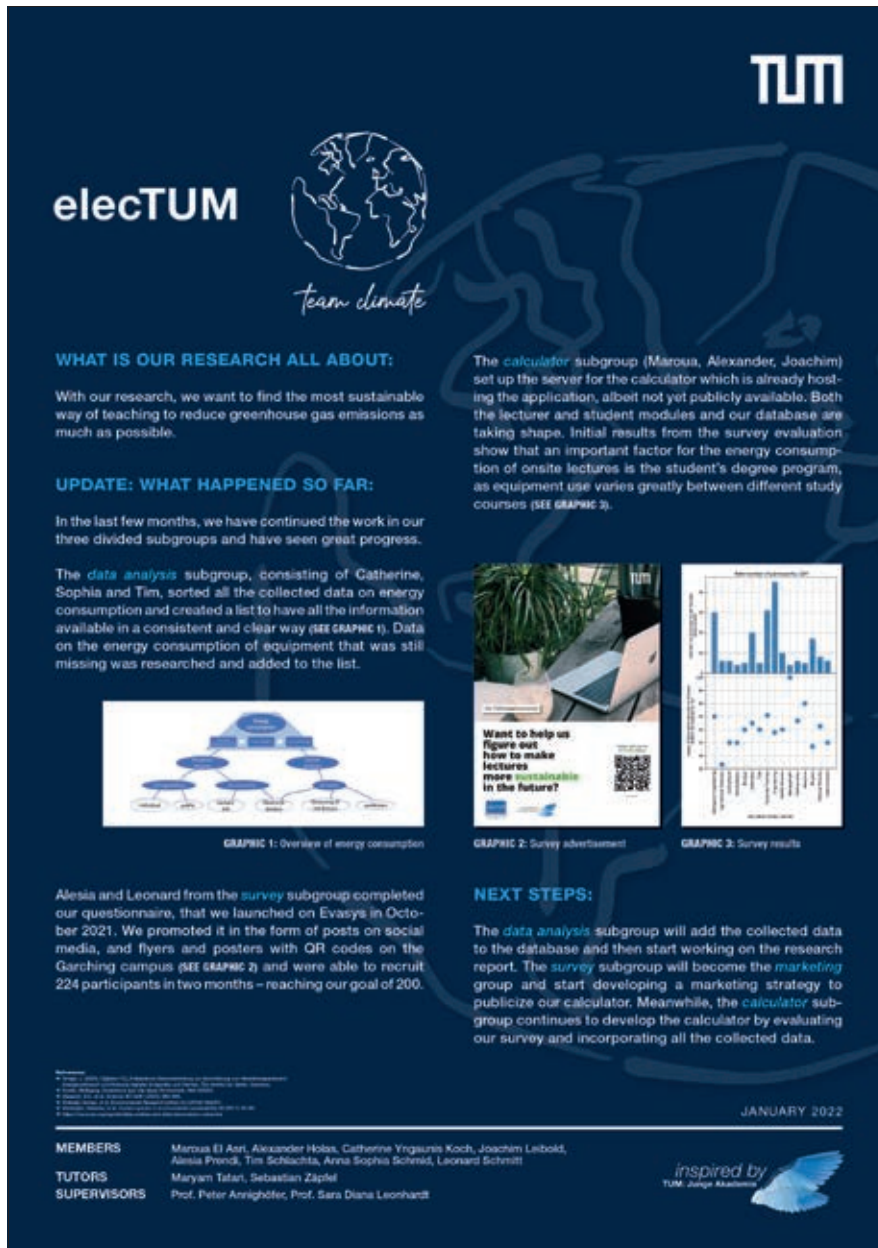
POSTER 3:

Between posters #2 and #3, we had our most effective months. The first subgroup was able to complete its data collection and organized the found data in an Excel spreadsheet. The second subgroup successfully launched the survey, which was answered by 224 TUM students! Lastly, the third subgroup set up the server for the web-based calculator. Having completed these essential steps, we had our last tasks clearly set for the upcoming months: the first subgroup would include all collected data in the database developed by the calculator subgroup; the survey team would become the "marketing team", responsible for making our project and calculator known at TUM and for designing the website; and the last subgroup would finish the development of the calculator and include the collected data (from the other two subgroups) in it.

POSTER 4:

After poster #3, in the final phase of our project, we included all collected data in our database, completed the development of our calculator, and conducted all calculations needed to answer our question on the energy consumption of lectures. After conducting such calculations, we came to the conclusion that, for the TUM reality, online lectures consume significantly less energy than on-site lectures. Now that we have these results, we plan on approaching the TUM administration to discuss possible ways of reducing the energy consumption of TUM students with regards to their lecture's formats. Further, to keep our project alive, in the last months, we have assessed different possibilities of expanding our calculator. For instance, we were already in touch with the organizers of the EuroTeQaThon and those of the TUMJA Science Hack regarding the possibility of including our calculator as a challenge in their hackathons.

Learn together!

Learning alone is like watching a movie without popcorn. Your perfect learning partner is waiting for you – what are you waiting for?

GET STARTED

Project Report **LETO**

In our project, we developed the learning platform LETO which connects students based on their course, learning styles, and personality traits.

The platform is based on a situation analysis for which we interviewed TUM students on their learning procedure. Thereby, we determined that the lack of learning-related interaction among students may impede efficient learning. To encourage collaborative learning we created LETO.

By May 2022, we had matched more than 100 TUM students.

Team   Philipp Patzelt
             Sara-Luisa Reh
             Luca Mattes Wiehe
             Valentin Roth
             Wolf Thieme

Tutors   Dr. Matthias Lehner
             Elena Tangocci

Supervisors Prof. Dr. Holger Magel
             Prof. Dr. Jürgen Pfeffer

Preface by the Supervisors

Prof. Dr. Holger Magel and Prof. Dr. Jürgen Pfeffer

Social interaction is at the core of human behavior. We interact with others to exchange information and discuss ideas. With the help of others, we learn and we grow. From the study of personal networks, we know that people with larger and more diverse networks are more likely to solve problems and to overcome professional and personal challenges in life. Being alumnus of a university is a key variable for having successful personal networks because student life offers many opportunities to make the acquaintance of new people. But also for short-term academic success, networks of learning partners and study groups are indispensable. And often, university learning partners will stay acquaintance or friends for life.

The opportunities to meet new people and to broaden one's personal network have been reduced dramatically due to the pandemic situation over the last two years. Many students have found it difficult to switch from face-to-face interaction in seminars and study groups to an online teaching environment. Moreover, our academic institutions are not prepared for pure online education and cannot support students with satisfying online networking alternatives. In particular, students in the first semester who have just come out of school have not been able to connect to the university and their peers through online seminars or have had no opportunity for social interaction. Here, a platform like LETO is a very good option for finding learning partners who are studying similar courses and who may also have similar preferences and characteristics. With the LETO matching tool, students have the opportunity to find like-minded people to fight their way through the learning jungle, to motivate each other, and, after many months of social distancing, maybe even find new interesting people for social interaction.

But even in a perfect university world without pandemic constraints, LETO can be an interesting opportunity structure for getting in touch with new people outside of one's own social circles. And last but not least, LETO can be an important tool in terms of increasing equity and inclusion since the online offer can be utilized independently from individual constraints.

Supervisor insights

Prof. Dr. Holger Magel, Professor emeritus since April 2012
The research activities of Prof. Magel (b. 1944) center on theories, methods and processes for forward-looking village renewal and participatory landscape planning. He also examines conflict-resolving land management in public infrastructure schemes (hydraulic engineering and road construction, residential planning, nature and water conservation, etc.). He is especially interested in analyzing land management and land administration in an international context. He set up the international postgraduate masters program "Land Management and Land Tenure in Urban and Rural Areas for Professionals" to examine this and other topics.

What is your research interest or motivation for science?
"There is the famous saying: Nothing is more practical than a good theory. This means that theory must be known if one wants to work practically. The theories that underly practical work emerge from science but should always be close to practice. As a full professor coming from a big engineering administration who was curious about building theories, I always tried to ground my own academic activities in practice. Grounding theory makes it possible that every researcher's dream becomes reality: scientific results are put into practice. I was fortunate enough to witness this several times."

What special experience from your studies/career would you like to share with the scholars?
"I would like to tell all young people at TUM: Junge Akademie the same I already told my own students and employees. During careers in the administration, the university and in Bavarian, federal and international professional associations, and NGOs, I made positive and negative experiences that let me conclude: Please never betray or deny yourself and your values; when it becomes difficult, try to think of the great Goethe, who in his educational novel Wilhelm Meister said for eternity: ,Dir frommt an jedem Ort, zu jeder Zeit Geradheit, Urteil und Verträglichkeit'" ■

The team discusses its findings with their supervisors Prof. Magel and Prof. Pfeffer.

LEarning TOgether – Platform out now

LETO, as LEarning TOgether, is a new educational platform that was launched in February 2022. The team behind it (Lu, Luca, Philipp, Valentin, Wolf) found that it was becoming increasingly more difficult to find suitable learning partners in study courses at universities. Over the years, courses have become larger and with the introduction of many new study courses, the number of students with which a person shares multiple courses has been reduced. Higher costs of living and lack of free student apartments have also made it necessary for many students to rent apartments outside the city center, making it more difficult for them to get to know their fellow students in classes. Finding the right people became even more complicated when the pandemic made it necessary to learn from home. While video recordings and online conference tools have enabled students to keep on learning, the members of team LETO have experienced first hand how much the interaction with other students has diminished within weeks. Whether it is homework groups that barely manage to reach their minimum size, a Zoom meeting full of people who have never heard of each other, or students feeling left behind in a lecture, students are not collaborating as much as is necessary for successful learning.

The general university setting and the pandemic restrictions together resulted in a severe lack of social and learning-related interaction among students. And this is where team LETO has come up with a solution that tackles exactly this issue, while keeping students' data privacy at its core.

The platform is an easy-to-use website, that matches students based on their personality traits and learning styles. To access matching based on these two categories, users answer a brief questionnaire during the sign-up process. The collected data is only used for the matching service and the scientific evaluation of the project but are not shared with any third parties.

Once the questionnaire is filled in, users can search for a study buddy or match while using a filter. At the moment, there are two major filter settings above all:

The most basic one matches two peers that are as similar in their personality traits and learning styles as possible but without any additional similarities. It can be accessed by clicking the "Match" button without any prior adjustments. The second major setting allows users to filter for courses within which they intend to find a study buddy. Peers are then matched by their personality traits and learning styles within a given study course. For this, the platform requires the user to set up a profile page that includes a list of courses a user participates in. LETO also recommends filling in the other fields on the profile page, like writing a short introduction for future matches. It is also noted that there are privacy settings for each field, so the user has full control over who can see what in their profile.

LETO, as LEcture Time Over, stands for the integration of the platform into day-to-day learning. Whether users only attend their lectures or use many learning organization tools, LETO is designed to easily fit into students' individual learning styles. It enhances the learning process in between established group chats, internet tutorials, sharing platforms, and cloud storage solutions. LETO focuses on providing a solid platform to find a learning partner which enables users to support each other mutually, provide peer-to-peer feedback, and motivate each other for learning goals.

LETO, as LEarn TOgether!, is the founders' appeal to all students which they base on two major arguments. The first argument is that learning together is more effective than learning alone. Studies have shown (cf. scientific report) that studying in collaboration is generally more effective than individual or even competitive studying, also when measured against outcomes for the individual. This applies to peer-to-peer learning and does not require, e.g., a mentor-mentee relationship. And even when two peers work through learning materials for the first time, they are likely to learn more effectively than both working by themselves. For the LETO platform, there might be the limitation that it cannot guarantee that two matched peers will automatically start learning together. This is why the team has planned to distribute motivational posts on social media and on the platform itself, to help lower the barriers to getting to know another person for the first time so that the two newly matched students can engage with one another more quickly. The second argument for the founders' appeal is that going through lecture materials together helps to prevent and overcome mental health issues. Many students experience high workloads from university while simultaneously working on the side which can impose a significant mental burden on them. Feeling left alone with this burden might cause more serious health issues but can be prevented or mitigated by talking with fellow students. The core goal of LETO is to enable students to learn more effectively and support each other.

LETO, as LEverage TOgetherness, stands for the future goals of Team LETO. Not only for LETO users, but also for the team behind LETO, matching is only the first step. The compatibility between two people is important. Making sure two students speak the same language (literally as well as figuratively) is a useful first step when establishing a cooperative environment. This environment again needs to be fostered actively. To provide all the important tools for the users, LETO is intended to benefit from additional, digital features to simplify and encourage online and offline collaboration. The first step is all about enhancing the matching algorithm as the fundamental base of LETO. For this, the team looks forward to evaluating detailed feedback from students of various faculties and schools to tailor the algorithm to the requirements of all students. In parallel, the team plans to launch motivational reminders via the platform and social media. The second step focuses on improving the design of the platform to make it more aesthetically pleasing and to add further matching and connecting features. These can help users to specify more concretely what they are looking for in a study buddy and to enrich their communication with the peer. Furthermore, additional motivating features like progress bars or badges might be added depending on the feedback. And finally, the third step aims to spread LETO to more user groups instead of focusing only on TUM.

LETO, as LEad TOmorrow, is the goal the team imagines for LETO users. Of course, there are many factors to the trajectory of a human life and LETO does not aim to single-handedly change everything. Rather, its goal is to be a noticeable part in a larger effort to make higher education more social. Currently, there is a strong but maybe somewhat misguided culture of competitiveness in education, but also in many other aspects of everyday life. While healthy competition is not inherently bad, a lack of healthy cooperation is. This is the exact gap that LETO intends to fill. And maybe LETO can—one day—even support users after their studies, in a new chapter of **LETO, as Let's Earn TOgether.**

LEarning TOgether – Counteracting deficits of online learning

Abstract

The COVID-19 pandemic has challenged established educational frameworks. Self-isolation made online learning ubiquitous and put its strengths and weaknesses into focus. Quick adaptations of existing lecture concepts for online learning environments increased the importance of individual and self-regulated learning. However, group work is a major success factor in learning and might be lacking due to the pandemic measures. It is unclear, though, which exact deficits university students experience during online learning and which potential solutions they propose. We conducted semi-structured interviews to discover patterns and deficits of online learning. We found that lack of group work and collaboration are one of the main deficits of online learning environments. Hence, we present the online matching platform LETO[11] ("LEarning TOgether"), which aims to increase collaborative learning among students by suggesting learning partners based on their character traits and learning styles. Further, LETO may be used to investigate and improve our matching approach by relating similarity scores to students' perceived quality of the enabled collaborative learning experience.

1 Background

Due to the COVID-19 pandemic, established educational frameworks had to be changed to online formats. An essential issue in integrating an online learning environment within COVID-19 is addressed by Hodges et al. (2020). According to them, the key to an effective online learning environment from an educator's view is the long-term planning and re-adjustment of digital teaching. However, measures taken in the course of the pandemic are largely enforced by governmental decisions without the possibility to fundamentally rethink a lecture concept. Thus, the actual situation regarding online learning at universities is not well understood, as changes to employed teaching methods happen rapidly and dynamically. Also, there are no standardized approaches to the new teaching methods, making them dependent on the specific institution and even specific lectures. This challenge on the side of educators simultaneously creates additional requirements for students.

As identified in a systematic review regarding self-regulated learning by Wong et al. (2019), students in online courses rely more on individual needs to maintain academic success. Therefore, the adjustability of online learning material according to individual needs is a major challenge for providers of educational content. Another challenge identified by Azevedo (2005) is the lack of a learning strategy for online learners. Without a self-regulated online learning strategy, many students struggle to maintain their academic success achieved in face-to-face classes.

Moreover, research regarding the effectiveness of group work shows that working in groups is more effective compared to entirely self-regulated learning environments (Gillies, 2016). The availability of group work in an online learning environment thus represents a possibility to overcome the challenges of self-regulated learning. This diversification of learning may play an important role in maintaining academic success despite an online learning environment.

Nevertheless, there is only little research about collaborative learning sessions in digital learning set-ups. Due to the COVID-19 pandemic, the idea of learning groups aroused greater attention among students and teachers at universities. One question is how to group students for effective learning.

As a first step to achieving deeper insights into this field, we investigated what deficits online learning at universities introduces and how those can be addressed.

2 Goals and Methods

Our goal is to investigate to what extent students demand changes in universities' online learning environments. More precisely, we aimed to answer the question ***What are the main deficits of online learning at universities and how can they be addressed?***

Without strong theoretical foundations for digital collaborative learning to build on, we concluded that conducting semi-structured in-

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1 LETO was developed in the context and with the support of the TUM: Junge Akademie (TUMJA)

terviews would be the best approach to discover patterns in the online learning situation at universities, including its deficits. The open-ended guiding questions of this format allowed us to gain deeper insights into students' perceptions of online learning and its experienced shortcomings.

During the interviews, we encouraged the interviewees to elaborate different points of view to get diversified status-quo descriptions of their online learning environment. To achieve that, we structured the interview to find out participants' different experiences with online learning at university around the main topics below:

- What does your learning process look like?
- What tools do you use?
- What does your typical learning day look like?
- What do you like about your approach and what works well?
- What frustrates you or does not work about your approach?
- What are some problems that arise during studying/watching/ lectures or revisiting notes?
- What would you like to happen that does not happen now?

We conducted nine interviews with students from different faculties at several universities. All answers were given with the background of recent switches to an online format of many universities in response to the first outbreak of COVID-19. Of those, seven were students at the Technical University of Munich (TUM); four were in their master's, and five in their bachelor's. The interviewees were distributed among six courses of study in six faculties and ranging between the 1st and 5th semester.

To analyze the interview answers, we ran a summarizing content analysis. First, we used a coding scheme to reduce statements that addressed the same or similar issues in the participants' answers. Hence, we iteratively aggregated key elements of the extensive interview protocols by condensing their contents from raw data themes to higher-order themes and eventually main categories. Additionally, we considered the origin of frequently mentioned statements to gain an in-depth understanding of the online learning situation and potential improvements.

3 Results

Results showed that the interviewees thought about several issues relating to online learning, which we split into three main categories: Firstly, poor instruction or organization, which was mentioned five times. Secondly, a lack of interaction, mentioned eight times. Thirdly, personal deficits, with eight occurrences as well. The following chapters will discuss the primary insights for each category.

3.1 Poor instruction

Of the five points raised in this category, four were about organizers being inexperienced with the new formats of their lectures. For instance, interviewees noted that online classes often exceeded their allotted time or were held too quickly. One interviewee said that "[the instructors] give a lot of input very fast and they don't even realize it." Another criticism was the lack of the instructors' adaptability and their use of unsuitable formats for an online environment. The last comment in this category mentioned lecturers not understanding questions during online lectures or poorly answering them. This suggests that communication in in-person lectures is more effective.

3.2 Lack of interaction

The second category could be split into two sub-categories: a lack of interaction between students and instructors (two mentions) and a lack of interaction among students (eight mentions). One interviewee expressed that when students do not know their instructors, they are often afraid to ask questions or voice criticism. As a result, they concluded, "bad practices or ways of instruction or behaviors are not pointed out and will continue to happen for the next cohorts." Regarding peer-to-peer interaction, answers describe missing social interactions, group work, discussions, and collaboration. The wish to have learning partners occurred three times (e.g. an interviewee said "[…] it is frustrating to not be able to call someone for help [...]"). One specifically described an outline for a system that would match students within the same lecture if they signed up for it to create an initial contact. They called it a "'I'd just like to not work alone, but don't know anyone'-bin." Another interviewee explained what such a matched partner would ideally look like to them as such: "Ideally [I would] have a study buddy that's a smarter

clone of myself." Three mentions stated that a significant source of stress comes from students not seeing the struggles of their peers and thus feeling left behind. One interviewee explained in this regard that they "[…] don't know whether [their] efforts make sense or are effective."

3.3 Personal deficits

For this last category, interviewees mostly explained their struggle with procrastination and developing good work habits when studying at home. One interviewee described their problem as "[…] if there is not a pressure or clear deadline given […], my tendency goes towards procrastinating." Another point is technological difficulties, such as being forced into a more computer-based workflow. One interviewee said that "[…] in e-learning everything happens very fast […], so being concentrated on the screen and at the same time taking notes is not easy." Other than the lack of time-management skills, interviewees described being subjected to a distracting and poorly structured environment at home, as well as having difficulties concentrating when only studying in front of their computers. One interviewee said that "despite using a separate device for work, being in [their] room still maintains a danger of being distracted." A similar problem was explained by another interviewee with the words "putting the smartphone away, I can resist temptation, but my apartment is too small for that to work perfectly."

4 Discussion

These results show that both instructors and learners were struggling with the new learning environment. This is in line with a recent publication by the TUM Senior Excellence Faculty describing the opportunities and challenges of Digital Teaching (Hutschenreiter et al., 2021). According to the authors of the article, it is a challenge for the future to make teaching at universities more enriching and give students the best possible preparation for their future as young researchers.

Of course, there is a need to involve several actors who deal with this challenge. It is uncertain which of the different approaches may succeed or not. In the current phase, it seems to be appropriate to try out several ideas and evaluate them scientifically.

One such idea is the project LETO ("LEarning Together"), which we implemented with the support of TUMJA. The project focused on the lack of interaction reported by some of the interviewees. It will be further explained in the next section.

5 A new approach: LETO

With LETO, we aimed to establish a platform to match students into effective learning tandems. To provide a solution for the issues mentioned in the category of missing social interaction, users can sign up and find other learners based on their active courses. Going beyond this goal, we attempted to optimize the resulting matches. To this end, we used a metric described in the following. However, it is unclear what an ideal learning partner would look like based on students' character traits and to what degree the availability of such a learning partner influences the success of collaborative learning efforts.

Existing literature examines the effects of character traits on job satisfaction (Therasa & Vijayabanu, 2014) and academic performance (Feyter, 2012). Komarraju et al. (2011) introduced learning styles as a variable to character models and Thanh et al. (2019) investigated character traits and learning styles in collaborative learning. The latter team identified 13 factors for participation in collaborative learning and used them in a recommender system. Yet, their matchings rely on what users are looking for in their peers. They did not further investigate what combinations of character traits and learning styles are favorable in learning partners. To address this gap in existing literature we aim to use LETO to investigate the effects of factors identified by Thanh et al. (2019) in the future.

LETO matches students based on personality, learning style, persistence, and time management. We use the Big-Five (Kessler, 2015) personality model and the Felder-Silverman model for learning styles (Felder & Spurlin, 2005). To establish a degree of trust in the matching, we intend to investigate the relationship of our matching inputs with users' perceived quality of the resulting collaborations. We will use a questionnaire developed and validated by Cohen & Manion (1990) to assess this perceived quality. Such an analysis could also be used to better understand how single factors used in

a matching correlate to the perceived quality, rather than analyzing the matching procedure in its entirety. This information has an immediate practical use for improving the matching. Currently, LETO has attracted too few users to draw statistically sound conclusions from such an analysis. It will therefore be delayed until the platform has had time to establish itself.

In addition to selecting the factors for the matching and its validation, there also is a trade-off between the immediacy of the matching and its quality. By delaying the matching, a pool of interested students could be maintained and would guarantee an optimal matching within that pool. Optimal here means that the matching maximizes the average quality [2] across all matches. This approach is especially viable if the user base is sufficiently large and delay times can be kept relatively short while still guaranteeing large pools. However, we chose a different approach to start with to account for smaller user numbers. As users will expect a certain level of interactivity, we present matches as soon as possible. This means the matches are only optimal with respect to the single user issuing the match and only at the time of the matching. The approach may be changed as the size of the user-base increases. In this regard, a further research question could be posed regarding how a delay in the matching of a certain length affects the users' perceived quality of the match.

Similarly to the delay considerations, matching groups of people makes sense with many users. Therefore, we chose to only match pairs of two at the beginning. To address the wish by some interviewees to find peers within their course, we allow a user to only match themselves among the students who participate in some user-defined selection of courses.

We currently have little support for post-matching interaction between the students. We mainly allow them to establish a means of contact on our website. A major reason for this design decision was that there already exist established services students can use to maintain contact. Examples are instant-messaging services or collaborative productivity tools.

Our main goal while designing the platform was to help students to find learning partners in an easy and promising way. We realized, however, that only enabling collaborative learning (e.g. by establishing contact) will not automatically guarantee it (Kreijns et al., 2003). Even though collaboration is shown to be generally more effective for learning than isolated studying (Gillies, 2016), students may be reluctant to pursue a joint effort. Therefore, a future goal of the LETO project is to help learning tandems create a constructive and fruitful collaborative environment.

Project-wise, LETO has only just started and therefore will offer more potential for future studies. After the matching aspect, more social networking features are a promising direction (Dabbagh & Kitsantas, 2011). Currently, the participants are expected to regulate their learning independently. This is problematic, as not all students have a high degree of self-sufficiency and might be less likely to benefit from each other without some guidance. Therefore, a short help document and regular reminders may already be helpful. A more involved approach could offer interactions on the platform that guide users to a fruitful collaboration. A current idea is to offer regular challenges that act as reminders with an incentive. We also consider social media features like an update feed that keeps users aware of their peers' activities. This should encourage positive competition. However, more research is necessary to gauge whether this kind of competition is productive. More specifically it would be important to understand when a competitive aspect is beneficial for a collaborative setting and when it is a hindrance. Any competition should increase motivation, but it should not reward sabotage. Thus, it is important to find a balanced incentive that

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2 Quality is measured by a score assigned to a match. The score is based on the Euclidean distance of the characteristic vectors of both students. A characteristic vector is a vector in the Cartesian space where all dimensions (Big-Five (five dimensions), Learning Styles (four dimensions), time management (one dimension), and persistence (one dimension)) are measured as values between 0 and 1.

is desired by students without being actually significant enough to lead to anti-social behavior. A specific first research direction would be to determine whether such a balance can be struck. Another simple update that could increase collaboration between students is to allow study groups of more than two people. However, with larger groups, students also need better self-regulated learning abilities. The number of inter-personal relationships in a group grows exponentially with the size of the group, thus quickly leading to increased complexity. This complexity introduces new potential conflict areas that students need to navigate. Thus, a first research question in that direction would be optimal group sizes in an online collaborative learning environment. The results from this research should then be integrated into the platform as additional guidance.

6 Summary

In our project, we performed a situation analysis based on semi-structured interviews to find common issues students have with online learning at universities. We determined three categories of issues that were commonly mentioned: poor instruction, lack of interaction, and personal deficits. We chose a project based on one of them. **The issue we address is a lack of interaction among students.** To address it, we created LETO, a web-based matching platform for students at TUM. Specifically, it addresses the common desire of students to easily find peers in their courses who are looking for a learning partner. Furthermore, we used personal characteristics to improve the matching beyond a random matching procedure. In the future, LETO could be used to measure the effectiveness of specific matching procedures.

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Self-reflection

"Learning Together" has been a theme throughout our past months in the scholarship and has ultimately manifested itself in the form of our matching platform LETO – Learning Together. In November 2020 and after some initial changes in the team, we started out as Team Education, a team consisting of eight students from diverse study backgrounds: Education, Health Science, Informatics, Medicine & Bioinformatics, and TUM-BWL. As it turned out later, this specific mix of backgrounds was ideal for our project.

From day one, we had a relatively clear idea of what we wanted to do: match students into learning tandems. We all longed for more social interactions in our learning process after months of online learning and wanted to change something about this! Our clear goal allowed us to move forward with our project and saved us valuable time in the beginning. Assigning roles from the very start also proved helpful to bring structure into the team and made our efforts more efficient.

We decided on Notion as our main platform for storing notes and documents and, in a first step, split our team into three sub-teams that conducted research on the theoretical background of learning, and on solutions already provided to tackle collaborative learning at universities/MOOCs (massive open online courses) and companies, respectively. Looking back, Notion significantly helped us with structuring the information we collected over time and the outputs we produced, but in our opinion, it is far from perfect. Reflecting on our initial progress, we are glad that we were lucky to agree on the same platform and final goal and that the three sub-teams turned out to be such a good solution to researching wider information while also continuing to work together and stay time-efficient.

As our second step, we planned and conducted interviews with fellow students. We wanted to check how our fellow students learned and prepared for exams and what they were missing in their learning process. After we had prepared the interviews, we faced the first hurdle: distributing our sign-up link and motivating students to participate. Back in December/January we mainly based our marketing on student group chats, RocketChat, and mouth-to-mouth propaganda, which did not return many students as a result. We learned from this, and stepped up our game in spring 2022, when we marketed our final platform, LETO. For starters, we created yellow posters and sent them to all TUM chairs and professorships and also hung them up ourselves on the TUM campus. We also visited lectures, which turned out to be probably the most effective marketing method for us, as we saw our numbers of participants almost doubling after the first two weeks.

After we had finished the interviews and confirmed that our idea could be popular among TUM students, we started working on the platform itself. Summer 2021 was spent mainly deciding on the features that we wanted to include in the website and programming it. Until then, the workload had been shifted more towards general research and the interviews, and now it changed more towards the informatics part of the project. We have been meet-

ing weekly, almost throughout the entire period of the scholarship, and all decisions have always been taken democratically. Whether weekly meetings were always necessary can be questioned, but it might also be said to have helped with maintaining motivation and continuity on the project.

And yet, by fall 2021, we had to face a major hurdle. We had hoped to finish a first version of our platform by the start of the winter semester but were confronted with difficulties in setting up a server and finalizing the programming. By the time we were ready to launch the platform it was February already, and most students were already through with their exams or right in the middle of them.

This issue was exacerbated by the fact that we had not finished all marketing materials and social media posts in time for the semester start. If we could go back in time and motivate ourselves to work harder in summer and fall 2021, we might have been able to successfully launch the platform earlier. Of course, it would have also meant a higher workload for everybody involved, not to mention everybody's commitment to university, work, and other TUM-JA projects.

While we have been working on LETO for the past months, we could always count on strong support from our tutors, Elena Tangocci and Dr. Matthias Lehner, as well as from our supervisors, Prof. Holger Magel and Prof. Jürgen Pfeffer. Both our tutors joined us for almost every single meeting, provided us with helpful feed-

back whenever we needed it, and brought us back to focus whenever we got lost in details or other possible pathways we imagined for LETO. Our supervisors helped us tremendously whenever we sought their support and opinions on our next steps and where to go with our website. A huge "thank you" to you for the continuous support and the time that you dedicated to us and LETO!
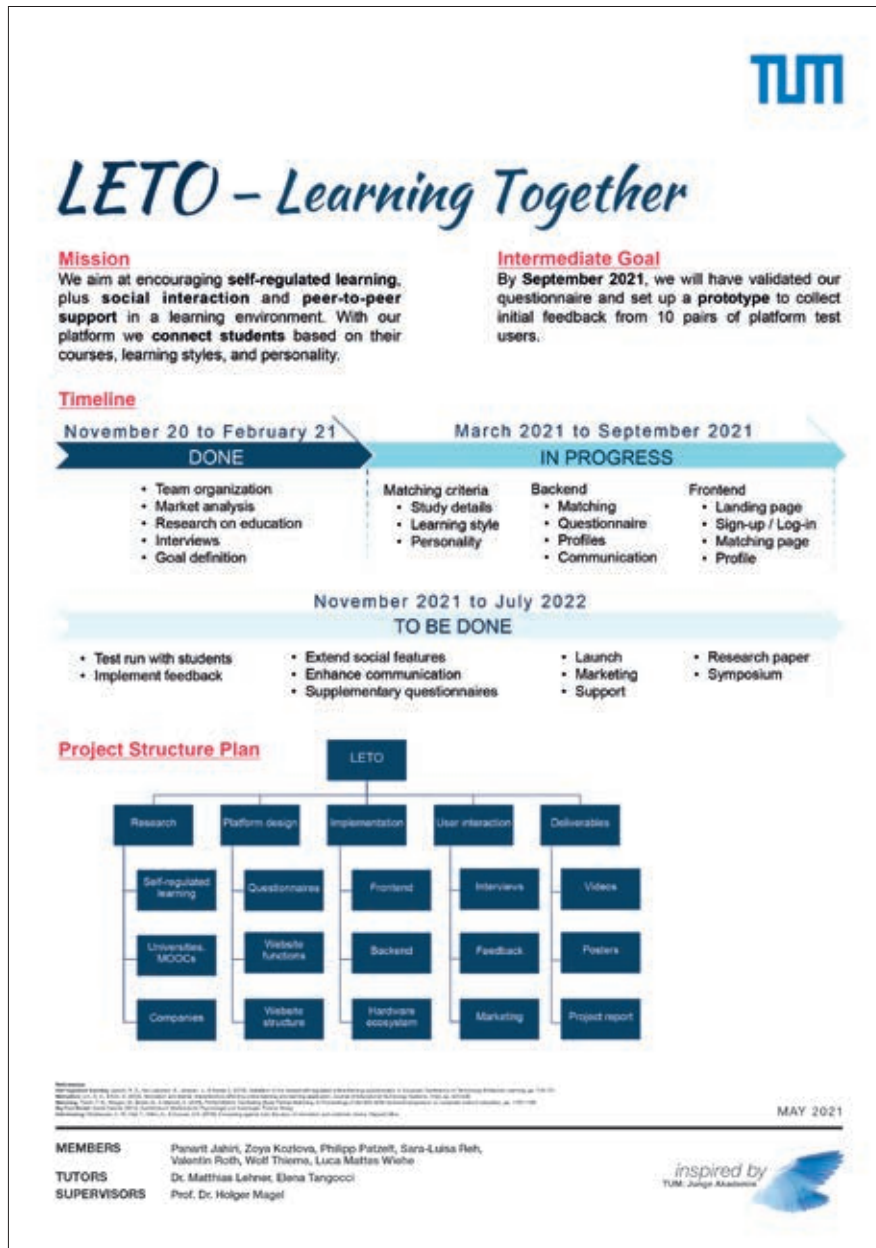
POSTER 1:

Right from the beginning, we wanted to work on a project about online collaborative learning. To find out which struggles students face during online university, we interviewed nine students in the scope of a survey in December 2020. Furthermore, we conducted an extensive literature research about online learn-ing, collaborative learning, self-regulated learning and learning platforms. Both the interviews and the literature research pointed out the importance of collabo-rative learning. However, it was not clear how to determine a suitable learning partner. As a tool for our research, we decided to create a platform, which connects students based on their cours-es, learning styles and personalities. Thereby, we aimed at encour-aging self-regulated learning, plus social interaction and peer-to-peer support in a learning environment.

From December 2020 till March 2021, we split the team in three subgroups: research, platform de-sign and implementation.
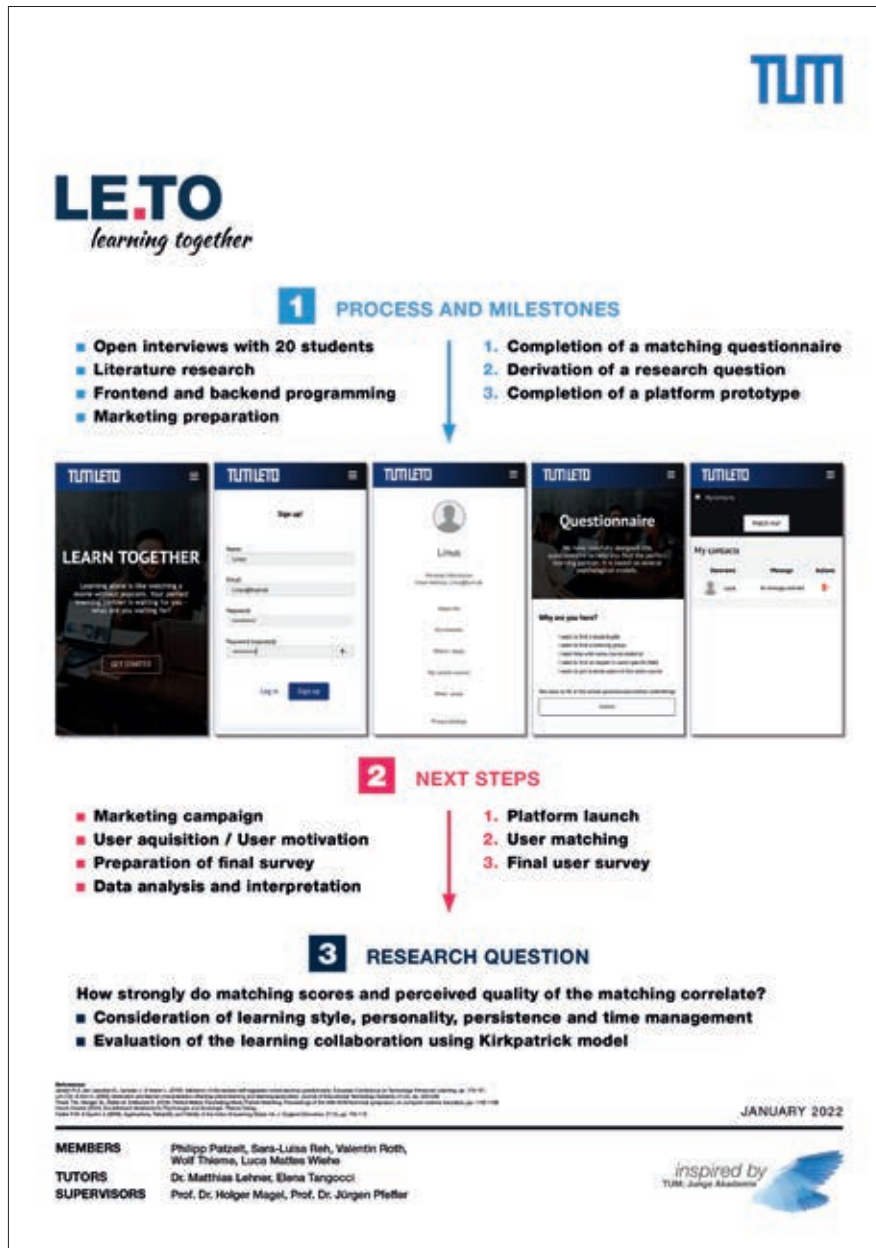
POSTER 2:

Our research team tried to find scientific approaches to selecting effective learning tandems. Afterwards, for each suggested criterion, we selected the appropriate measuring instrument. Finally, we derived a questionnaire for matching learning tandems.

Meanwhile, the platform design group reflected on a suitable name, logo, color palette, and font for our platform. In the end, the team decided on the name LETO, which stands for LEarning TOgether, but also occurs in Greek mythology, as Leto was the mother of Apollo and Artemis. Furthermore, the platform design group devised the frontend (user interface of the platform) and relayed their ideas to the implemen-tation group.

POSTER 3:

We employed the React-framework for our frontend. To program the corresponding backend (server) we chose Django, a Python-based web framework. We used an agile approach to coordinate additional fea-tures and priorities. During the development process, the platform design team evolved into our marketing team. They prepared the steps necessary to address a large user base with our platform. To realize this goal, they designed flyers and posters that could potentially be distributed physically or via online plat-forms. We ended up having a first prototype for our platform, which we used to test the features with a small number of user accounts.

POSTER 4:

In the final stage of the project, we continued improving the online platform and launched it to a web-server with the domain https://leto.ja.tum.de. Having launched the platform, we started visiting lectures, distributing posters and flyers, and talking to other students to make people aware of LETO. This way, we were able to attract 150+ users to join our platform to find their learning partners. Between those us-ers, over 230 registered matches occurred on our platform. Our background knowledge from the initial research together with insights from the interviews and the attention that our platform gained, we can draw the conclusion that LETO indeed addresses a market gap that was previously unfulfilled. The high interest that LETO garnered from students at TUM poses the question of whether the high demand is transferable to other universities and research institutions to foster collaborative learning. Therefore, LE-TO's stakeholders include language centers, student associations, faculties, universities, and possibly even schools.

Project Report **Proactivation**

Team Proactivation dedicated themselves to decreasing procrastination in students. Procrastination describes the involuntary act of postponing pending tasks with negative consequences on a collective and individual level. It portrays a severe challenge, especially for students, and has an impact not only on academic performance but also on mental well-being. To help with this, Team Proactivation designed an anti-procrastination online course that aims at equipping students with a metacognitive skillset. The course spans three weeks and consists of short videos and a workbook helping students to implement the knowledge gained from the videos.

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Preface by the Supervisor

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Procrastination affects all of us. As a professor, I experience it all the time. While I am generally good at keeping up with deadlines, for instance by making prioritized 'to do' lists, some things seem to always end up at the bottom of the list over and over again. With the PhD students and postdocs in the laboratory, who are hard-working and very motivated individuals, I find that some things just never get done (like writing a report or doing an annoying experiment). Working with bachelor and master students, I get a similar picture: writing reports, essays and alike or preparing for an exam in time seems so hard. I am also a mother and see the same with my children. Unfortunately, this procrastination is not only irritating, but also harmful as it results in missed opportunities, failed exams, loss of trust, and the general unpleasant feeling of falling behind.

During the Covid-19 pandemic, it became painfully obvious that procrastination is less a result of too much partying or spending time on one's hobbies, but rather a lack of peer-group support. As humans, we are highly social animals. Social interactions help us to not only feel better (at least sometimes) but also to structure our days. Why exactly people procrastinate and what they believe could help them to ameliorate it, remains unclear.

The TUMJA team 'Proactivation' has tackled this question in two ways. First, they took the academic approach and researched the topic extensively through existing literature, talking to scientists, considering related studies, surveys and so on. In their survey of over 800 participants, they discovered that over 70% of students report suffering from procrastination academically and mentally. Next, they developed a practical approach to help students experiencing procrastination to figure out what support they lacked and which measures could help them to boost motivation and discipline. To this end, they developed a web-based course with questionnaires, information and training videos and materials to help students help themselves. The first round of this course provided promising results: students who successfully finished the training reported a significantly lower level of procrastination and an increase in mental well-being.

For me, working with this talented and ambitious group of TUM students was a great opportunity and experience. I am very impressed by what they have built as a team, especially during times of social isolation. I am convinced that the tool they've developed is a powerful step to improve students' mental well-being and academic success. ■

#giveyourlastminuteabreak

Nicole has already cleaned the apartment today, did half an hour of yoga, went for her groceries, and did her laundry, and the laundry of her boyfriend. Up to here, it sounds like a productive day. But Nicole has not yet opened her laptop to work on her programming homework for her computer science class. Although she spends the whole day thinking about it. The assignment is due tomorrow, with 18 hours to go, so, again, a last-minute assignment.

More than 90% of students feel like Nicole sometimes. They know they should do their homework, study, or write an essay. But instead of working on it, they put it off, they procrastinate. Procrastination is much more than just delaying work. It describes the irrational delay of actions leading to subjective discomfort. That means that we put off tasks we actually know we should work on now rather than later. And while we do that, we feel so guilty about it that we harm ourselves. Nicole has been thinking about her programming exercise the whole day and feels an ever-increasing pressure to start. The pressure leads to guilt and guilt leads to anxiety and stress. But Nicole is no exception. Over three-thirds of students report that procrastination affects their mental health. Health and procrastination are linked in several ways. The most evident link might be that procrastination affects our mental health as we feel guilty and more stressed, as Nicole does, the closer the deadline approaches. The same holds the other way around. Our mental health also affects our procrastination habit– a vicious circle. Procrastination also affects our physical health, if, for example, we procrastine about going to the fitness studio, or making that dental check-up appointment. Apart from impacting our health, procrastination also affects academic performance.

There are many explanations for why people procrastinate. Some experts find evidence in basic personality traits that lead to pro-crastination. But it is more than just a problem of personality. One theory states that while procrastinating we actually just try to avoid negative feelings associated with certain tasks, e.g. we anticipate the difficulties, disappointment, and the feeling of failure and thus do not start the task at all, or at least do not start it until the last minute. No wonder we do fail then. What a great excuse we just found! The temporal motivational theory finds a more mathematical approach. It defines an equation describing the motivation for a specific task dependent on four variables, namely expectancy, value, impulsiveness, and delay. The higher our motivation for a task, the lower our urge to procrastinate. And while expectancy – the confidence of achieving an expected outcome – and the value assigned to the outcome have a positive effect on motivation, impulsiveness – the inability to forgo immediate gratification –- and delay – the time that passes until the deadline – have a negative effect. In short, the more confident we are in achieving a result and the more value we assign to the result, the less we procrastinate. A long deadline and our inability to ignore short-term distractions lead to more procrastination. Other explanations draw on the intention action gap – a theory of how we are not really lacking intentions, but the actions needed to implement them – or phenomena like planning fallacy, or future discounting. Whatever scientific theory we take and whatever latest evidence we find, one thing we should note, is that procrastination has nothing to do with laziness or lack of ambitions. Instead, stigmas like these lead to a lot of students feeling ashamed of what at first sight seems to be a problem of productivity. And if the last two years have taught us anything about how to handle mental illness, it's that stigma is the last thing we need.

However, there are things that might help when students procrastinate. Understanding the problem is the first step, hands-on methods and techniques are the second, and applying those to everyday

life is step number three. At TUM, a student research project has developed a solution aiming exactly at those three steps. It is an online course named Proactivation. Within nine short videos, it explains the scientific background of procrastination, provides methods on the topics of time management, goals, and focus, and comes with an exercise book to implement those methods directly. Nicole learned about the course in her linear algebra class. The professor mentioned it at the beginning of the class and then continued to speak about the latest exercises. Nicole had the feeling that she would probably not have a closer look at those exercises until shortly before the exam and maybe that thought was the reason she checked the Proactivation website later that day.

One method she liked from the start was the weekly planner. She could preorganize her week and hold herself accountable for the things she does not do, and celebrate things she achieves. Another method is about how to avoid task switching. Nowadays technological distractions are inevitable and make it hard to focus. Sometimes it might even feel like they are forcing us to procrastinate by hanging out on Instagram, TikTok, and co. Experiments show that students spend on average less than six minutes studying before switching to another task, mostly texting or social media. At the same time, banning the phone and social media completely gives rise to internal distractions and simple FOMO –- fear of missing out what's going on right now. Through organized technology breaks and time management methods like the pomodoro technique, Nicole minimizes distractions. In particular, the pomodoro technique helps her because she is able to have fixed times for focusing and fixed times for breaks to reward herself for staying focused. "My favorite method for effective studying is the Pomodoro Technique. I work for 25 minutes, take a 5-minute break, and work for 25 minutes again." Nicole repeats this cycle four times until she takes a long break.

"Because of the limited time I concentrate, I'm much less distracted," she says.

But Nicole is not the only one to have benefited from Proactivation. More than 600 students have already registered for the course and the majority of those who have already finished it claim it has helped them in their battle against procrastination. Those improvements can even be made tangible by using the PPS, a procrastination scale ranging from X to X that is commonly used nowadays in scientific discourse. After finishing the course the average score of the students decreased by 4 points.

What stood out was how many participants noticed an increase in their conscientiousness. Most participants stated that in preparation for deadlines they often waste time by doing other things. However, after completing the course, the average score on this question decreased from 4.2 out of 5 points to 3.3 points. Especially effective here were time planning methods like the ALPEN method and day planning.

Nicole is working on a submission right now. In a week she has to present a classification algorithm she programmed herself. "Actually, I'm already done," she says, laughing. "There are still a few things I can improve, but it's not much." Nicole has a date this afternoon and is looking forward to her free time. "I didn't think I'd ever be done a week before submission in my studies," she says. "I like to spend the time I gain in cafés or with my boyfriend. He's really happy about it, of course," Nicole grins and sets off to make it to her date on time. ■

Proactivation

Abstract

Procrastination describes the involuntary act of postponing pending tasks with negative consequences on a collective and individual level. It presents a severe challenge, especially for students, and research is yet to determine its causes and effective countermeasures. For the 31 participants in our study, we designed a three-week online course – the Proactivation course – which is aimed at reducing procrastination and evaluating its connection with mental well-being. By implementing the Pure Procrastination Scale (PPS) and WHO (Ten) well-being index (WHO-10) in a pre- and post-intervention survey, we found a significant decrease of the PPS mean score, but no significant changes of the WHO-10 mean score. In other words, participants experienced a measurable (subjective) increase in their productivity without a significant improvement of their mental well-being. That said, the reduced procrastination might yet have a positive effect on their well-being, which merely may not present itself in the short term.

1. Introduction

a. Background

For many people, procrastination constitutes a highly prevalent and severe challenge. In particular, students are affected. According to a study of Steel in 2007, 90% of students stated that they procrastinate, 50% of those even on a regular basis. The phenomenon describes the irrational and involuntary act of delaying pressing tasks even in the face of resulting negative consequences. While procrastination is an inherent part of human behavior and is considered normal to a certain degree, the magnitude of the consequences and possible countermeasures remain widely unknown.

Determining the causes of excessive procrastination presents a complex and controversial issue in the field of psychological research. Some explanations focus on the connection of procrastination and specific personal traits. For instance, they underline the increased susceptibility to procrastination in subjects who display a high degree of impulsiveness, lack of self-control (Rozental and Carlbring, 2014) and a low frustration tolerance (McFadden, 1999). Moreover, irrational and dysfunctional beliefs including fear of failure, perfectionism (McFadden, 1999) and unrealistic expectations (Rozental and Carlbring, 2014), are directly linked to procrastination.

In addition to that, sociodemographic and cultural differences need to be taken into consideration. It is well-known that procrastination correlates with age (O'Donoghue and Rabin, 1999; Banich, 2009), as the perception of time changes, and with gender (van Eerde, 2003). Furthermore, some scientists attribute the tendency to procrastinate to cultural characteristics. Having an impact on goal orientation, they shape whether the individual's priority lies in the development or in the demonstration of one's skills (Liem and Nie, 2008). Accordingly, significant differences between Western and Eastern cultures could be shown (Dekker and Fischer, 2008).

Nonetheless, the extent of negative consequences resulting from procrastination is tremendously underestimated. Studies have shown that procrastination has a negative impact on academic performance resulting in lower scores in papers and exams (Tice and Baumeister, 1997). Furthermore, a higher engagement in scientific misconduct, including falsification, fabrication and plagiarism, could be observed in relation to procrastination (Patrzek et al., 2015).

On top of that, the effects of procrastination on mental health are of major importance. In Stead et al. (2010), a link between procrastination, stress and mental health is established. Studies have shown that various negative associations such as depression and anxiety are related to procrastination (Saddler and Sacks, 1993). Additionally, social stigmas can aggravate the individual's psychological distress.

Consequently, discovering effective techniques which counteract procrastination are essential and of high public interest; this is especially true for students. For this purpose, we designed a 3-week online course, the Proactivation course, to pursue this endeavor. As we aim to reduce the amount of procrastination and quantify its effects on mental health, we hypothesized that the Proactivation course could decrease procrastination in students and, thus, lead to improved mental well-being.

b. Motivation and course composition

To estimate the prevalence and severity of procrastination, we conducted a pilot study with 805 participants. The results showed that 74.2% found themselves often procrastinating, 65.9% stated that

procrastination affects their academic performance and 77.0% stated that procrastination affects their mental health. Furthermore, positive correlations of procrastination with lack of time management, trouble concentrating and distraction by technical devices could be found. This alarming data motivated us to design the Proactivation course. Within the course, we present hands-on methods which aim to improve motivation, time management and focus.

In addition, we aim to raise awareness about procrastination and to contribute to a deepened understanding of this complex psychological phenomenon.

2. Methods
a. Study Design
The data collection is designed as a controlled trial. Procrastination behaviors and mental well-being were measured before participants took the three-week online course and again after they finished it. To enable all participants to experience the online course, we did not include a control group in the study design.

b. Recruitment and Marketing
Various channels were used to recruit participants for the online course. Firstly, flyers promoting the launch of the course were handed out to all student councils of the Technical University of Munich for further distribution. Secondly, an Instagram channel was created to promote the course. On average two or more posts a week have been published on the channel during the period from September 2021 to February 2022. The Instagram channel gathered 857 followers (until the date: 28.03.2022). Furthermore, the Instagram channel "mitvergnuegen_muenchen" (with about 138,000 followers) additionally promoted the course within an Instagram post and story. The radio station "Antenne Bayern" also promoted the course by interviewing one of the team members in a program section. Finally, advertising has also been carried out by the team members through promotion in their respective social environments, e.g., through posts in WhatsApp groups shared with fellow students.

c. Intervention
The intervention is designed as a 3-week participation in an online course. The online course was accessible through a webpage which

was implemented with the help of the website builder Coachannel. Once the participants started the online course, they could view three lessons a week. The main content of a lesson is presented through an animated video of, on average, five minutes' duration. Some parts of the animated videos covered scientific facts about procrastination and mental well-being. Other parts dealt with practical tips on how procrastination can be decreased and on how to deal with mental strains such as stress. Within the animated videos, the participants were encouraged to apply the practical tips with the help of the course's accompanying workbook. Examples for exercises that should have been carried out in the workbook include denoting long-term goals or to time-plan writing. Furthermore, additional videos on topics such as physical fitness or benefits of meditation were supplied for voluntary use. An elaborate description of the contents of the online course is given in the Supplement.

d. Questionnaires
To evaluate the effect of the online course on the procrastination behavior and the mental well-being of the participants, two surveys were conducted. One survey had to be filled out before viewing the first lesson and one had to be filled out after completing the last lesson. The two surveys are mostly equal, although in the second survey additional questions were added to capture general feedback with regard to the online course. The two surveys implemented the items from the Pure Procrastination Scale (PPS) (Steel, 2010) and the WHO (Ten) well-being index (Bech, Gudex, and Johansen, 1996). Both are approved in the scientific community (Svartdal and Steel, 2017; Topp et al., 2015). The former aims to evaluate procrastination behavior, the latter aims to evaluate mental well-being.

e. Outcomes
The PPS encompasses eleven outcomes. Each outcome consists of a categorical statement. The statements are as follows: "I delay making decisions until it's too late.", "Even after I make a decision I delay acting upon it.", "I waste a lot of time on trivial matter before getting to the final decisions.", "In preparation for some deadlines, I often waste time by doing other things.", "I often find myself performing tasks that I had intended to do days before.", "I am continually saying 'I'll do it tomorrow'.", "I generally delay before starting on work I have to do.", "I find myself running out of time.", "I don't get things

done on time.", "I am not very good at meeting deadlines.", and "Putting things off till the last minute has cost me money in the past."

Participants respond to the statements on a 5-point Likert scale, where the options are: "Strongly disagree" (1 point), "Disagree" (2 points), "Neutral" (3 points), "Agree" (4 points), and "Strongly agree" (5 points). The calculation of the total PPS score is simply an addition of the individual points from each question. Therefore, the maximum score is 5*11=55 points which represents the most pathological procrastination behavior.

The WHO-10 includes eight outcomes which are represented by: "I feel downhearted.", "I feel calm and peaceful.", "I feel energetic, active or vigorous.", "I have been waking up feeling fresh and rested.", "I have been happy, satisfied, or pleased with my personal life.", "I have felt eager to tackle my daily tasks.", "I have felt I could easily handle or cope with any serious problem or major change in my life.", and "My daily life has been full of things that were interesting to me."

The prompt to each question is: "Please choose a number on each of the following statements to indicate how often you feel each of them has applied to you in the last week." The options are given by the four numeric values: 0,1,2, and 3. Similarly to the PPS, the points are added up for a total score (the first outcome is inversely weighted). Consequently, the maximum score is 3*8=24 which indicates the best possible well-being.

f. Data Analysis
Descriptive data of study participants is presented by mean values, standard deviations (mean ± SD) and absolute numbers and percentages, if appropriate. The normal distribution of the outcome parameters was tested with the shapiro-wilk test and graphical distribution. To analyze whether the Proactivation course had an effect on procrastination behavior and mental well-being, outcome measures before and after the course were calculated to a mean score and compared with a paired Student t-test. All analyses were performed with SPSS (V28.0, IBM Corporation), with the level of significance set to two-sided p-values < 0.050 for all tests.

3. Results
a. Study participants
Overall, 31 participants complete the online course and the pre- and post-survey. Of these participants, 12 (38.7%) were female and all but one participant were students. At the time of participation, 39% were at an age of 18-21 years, 42% at 22-25 years, 16% at 26-29 years, and one participant was over the age of 29 years. The distribution of the educational backgrounds of the participants is displayed in Figure 1.

b. Pure Procrastination Scale (PPS)
Before starting the intervention, the mean PPS was 37.71 ± 6.7 and decreased to 33.84 ± 9.5 after finishing the course. Therefore, the Proactivation online course significantly reduced the procrastination measured by the PPS (t(30) = 5.31, p<0.001); see Figure 2.

Table 1 shows the single domains of the PPS questionnaire before and after the intervention. All but three of the overall eleven domains significantly decrease, indicating reduced procrastination, after the 3-week online course.

c. WHO (Ten) well-being index
The mean WHO-10 score was 19.39 ± 4.0 before the intervention and 20.84 ± 4.1 after finishing the online course. However, this increase is not statistically significant (t(30)=1.54, p=0.134); see Figure 3.

Table 2 shows the single domains of the WHO (ten) well-being index before and after the intervention. None of the domains significantly changed with the online course.

d. Individual Feedback
In the post-survey, participants had the option to give feedback on the online course. One question was dedicated to examining which of the methods we provided the participants found especially useful
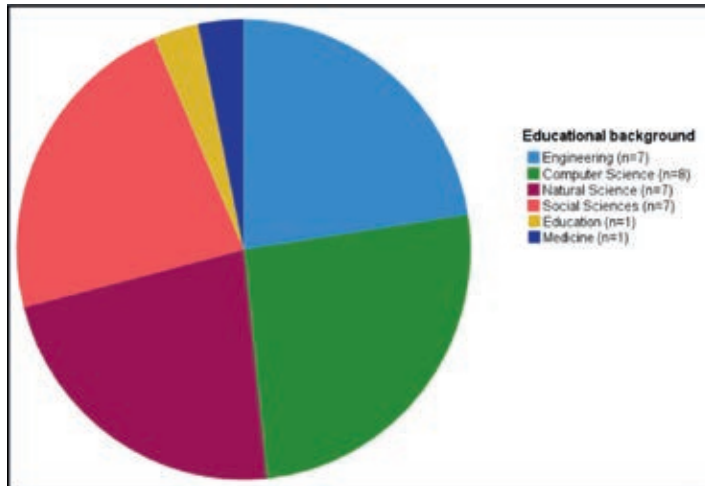
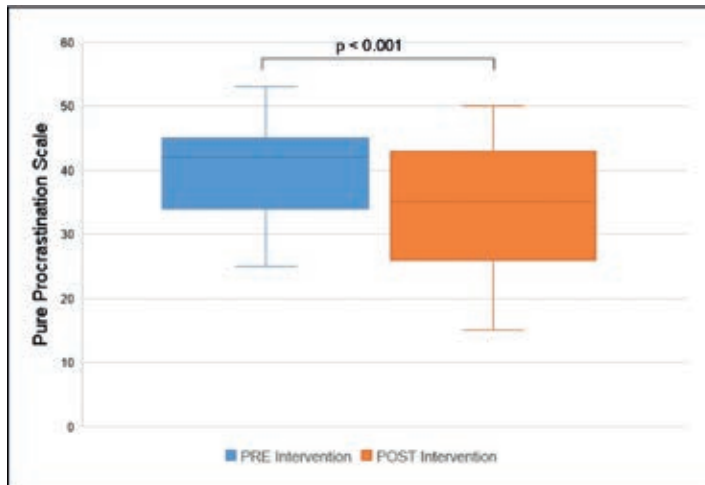Figure 1: Educational Background of study participants.

Figure 2: Pure Procrastination Scale before and after Proactivation course.

Domain	PRE-Intervention	POST-Intervention	p-value*
I delay making decisions until it's too late.	3.55 ± 0.925	3.10 ± 1.044	0.320
Even after I make a decision I delay acting upon it.	3.61 ± 0.989	3.35 ± 1.112	0.040
I waste a lot of time on trivial matters before getting to the final decisions.	3.84 ± 1.369	3.23 ± 1.230	0.014
In preparation for some deadlines, I often waste time by doing other things.	4.19 ± 1.046	3.35 ± 1.091	0.001
I often find myself performing tasks that I had intended to do days before.	4.19 ± 0.946	3.35 ± 1.33	0.42
I am continually saying "I'll do it tomorrow".	3.68 ± 1.166	3.06 ± 1.263	0.003
I generally delay before starting on work I have to do.	4.13 ± 0.922	3.45 ± 1.028	< 0.001
I find myself running out of time.	4.26 ± 0.815	3.39 ± 1.202	< 0.001
I don't get things done on time.	3.06 ± 1.181	2.74 ± 1.264	0.030
I am not very good at meeting deadlines.	2.61 ± 1.145	2.13 ± 1.088	< 0.001
Putting things off till the last minute has cost me money in the past.	2.76 ± 1.504	2.66 ± 1.421	0.055
*Differences calculated by paired t-test. Bold values indicate significant differences.			

Table 1: Comparison of PPS-domains pre- and post-intervention.

Category	PRE-Intervention	POST-Intervention	p-value*
I feel downhearted.	2.58 ± 1.089	2.39 ± 1.022	0.518
I feel calm and peaceful.	2.48 ± 1.092	2.71 ± 1.039	0.398
I feel energetic, active o r vigorous.	2.45 ± 0.810	2.77 ± 0.845	0.408
I have been waking up feel-ing fresh and rested.	2.19 ± 0.980	2.42 ± 0.923	0.375
I have been happy, satis-fied, or pleased with my personal life.	2.68 ± 1.013	2.84 ± 0.969	0.081
I have felt eager to tackle my daily tasks.	2.29 ± 0.824	2.68 ± 0.945	0.170
I have felt I could easily handle or cope with any serious problem or major change in my life.	2.26 ± 0.930	2.48 ± 0.962	0.061
My daily life has been full of things that were interesting to me.	2.45 ± 0.850	2.55 ± 0.888	0.583

*Differences calculated by paired t-test.

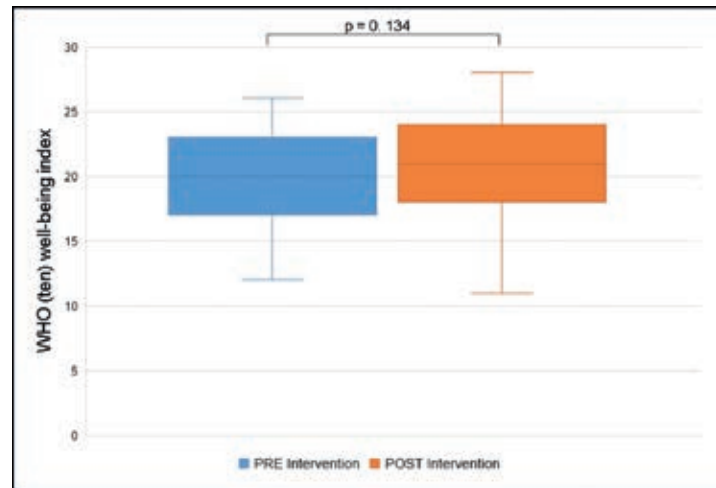Table 2: Comparison of WHO (ten) well-being index domains pre- and post-intervention.

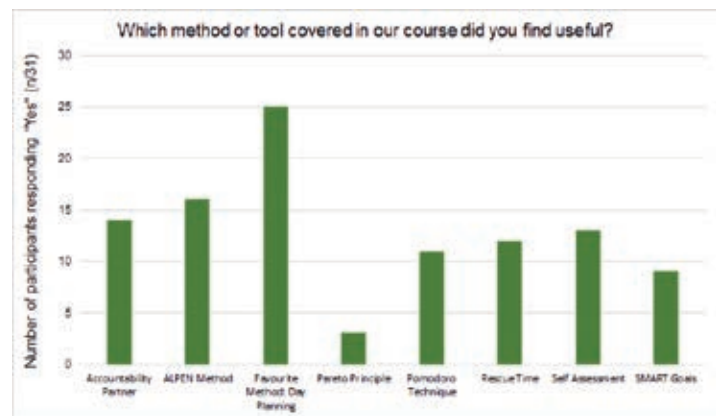Figure 3:WHO (Ten) well-being index before and after Proactivation course.

Figure 4: Perceived utility of the techniques covered by the Proactivation course.

(see Figure 4). With the endorsement of around 81% of participants, a proposed method to help with day planning was considered to be of the highest utility. Other proposals, such as reporting to an accountability partner, utilizing the ALPEN method, the Pomodoro technique, the app Rescue Time, self assessment and SMART goals, achieved endorsements of 29% to 52%. The utility of the Pareto principle was deemed useful only for 10% of the participants. The results indicate that in the perception of the participants, hands-on methods which aim to improve time management were most useful to counteract procrastination.

On another feedback question, participants could report on habits they have incorporated into their daily lives (see Figure 5). Interestingly, the course materials about sports, nutrition and sleep which were supplied for voluntary use are, with 90% supporting participants, of very high popularity. Furthermore, 84% participants report that they have acquired the habit of consciously setting up their work environment. 67% of participants also reported that putting distractions, such as their mobile, in another room became part of their daily lives. The usage of background music during learning achieved a percentage of 58%.

4. Discussion

The goal of our study was to determine whether participation in the 3-week online (Proactivation) course has positive effects on procrastination behavior and mental well-being.

The longitudinal analysis showed that the value of the PPS scale reported by the study participants decreased by 5.31 points with significant evidence from the pre- to the post-survey. In particular, the value of eight out of eleven ordinal variables has reduced significantly (see Table 1). The other three ordinal variables which show no significant trends also all decreased on average. We argue that significant results for these three ordinal variables were not achieved due to multiple reasons. On the one hand, the total number of participants (n=31) is small which makes it hard to detect minor trends. On the other hand, the considered items of the PPS scale may not
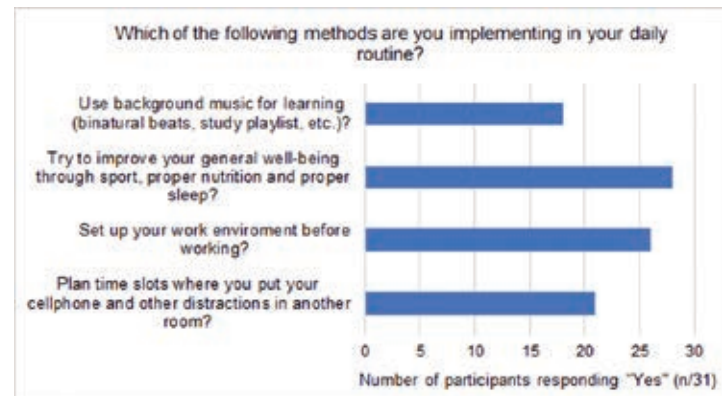

Figure 5: Frequency of people that implemented selected methods into their daily routine.

be of relevance with regard to the intervention design, i.e., influencing the way participants make general decisions was not the focus of the intervention. Thus, Question 1 of the PPS scale may show no significant trend. Furthermore, the participants were surveyed in a three weeks' duration. Therefore, it is probable that effects on items like Question 11 which target long-term experiences could not be covered. Overall, we conclude that the intervention had significantly positive effects on the procrastination behavior of the participants. This finding is in accordance with previous literature. Steel (2007) supports the view that interventions that help participants to exercise the skills of self-regulation, goal setting and time management improve their procrastination behavior. Rozental et al. (2015) supports the finding that this can readily be achieved with an online-based intervention.

Effects of the Proactivation course on the mental well-being of the participants could not be shown with significant evidence. However, all ordinal variables in the WHO (Ten) well-being index increased on average (the inversely weighted Question 1 decreased) (see Table 2). Sirois et al. (2013) notes that it was shown in multiple studies that

feelings of accomplishment and progress fuel mental well-being. Since there is strong evidence that the present intervention improves procrastination behavior, which should also increase these feelings, mental well-being may be increased in the long term. However, until further research this remains conjecture.

Limitations of the Study

Our study design does not allow us to determine long-term effects of the Proactivation course, as this would require multiple follow-up surveys. Furthermore, the study relies solely on the self-assessment of the participants. After the participants spent time thinking about their procrastination behavior, through participating in the online course, they might have become more inclined to assess that they have now incorporated productive practices more than they actually have. To filter such effects the study would need to be supported with other data collection, e.g., measures that assess their actual (academic) performance pre- and post-intervention. Furthermore, due to no monitoring of the participants completing the online course, it is unclear if the participants engaged with all the content provided. Finally, the participants only cover a small demographic group, i.e., university students of age between 20 and 30. The course might have a different efficacy for other professions or age groups.

5. Conclusion

Our three-week course achieved the goal of decreasing procrastination in students measured by the PPS scale while no significant effect on their mental well-being could be measured on the WHO-10 scale.

The educational approach of offering students various methods for reflecting on their work habits, goal setting and time planning has shown to be effective. Furthermore, the intervention considered here, an online course, is easy to maintain, can be made available to a large number of people and is accessible at any time.

6. Supplement

Description of the Proactivation course

Week 1

■ *Day 1 – Introduction to the course*

In this first video, the relevance of the topic of procrastination is explained. Additionally, an introduction to ourselves and an explanation on how the course is structured is given. Furthermore, our workbook is announced, which guides the participant throughout the course (see Figure 6). As a first exercise in the book, the student should reflect on when, where and why they usually find themselves procrastinating.

On Day 1, a supplementary video is offered, where we introduce the accountability partner. The accountability partner serves the purpose of providing light social pressure, whereby the participant shares the goals they have set for themselves for each day or week with their partner.

■ *Day 2 – Setting 'SMART' Goals*

The importance of setting goals is highlighted via a scientific study. It is concluded that setting precise goals, including an accountability partner as well as a reward system provides large benefits with regards to goal achievement. With this, the 'SMART' goal technique is introduced as a structure plan for setting goals. The workbook exercise for this video serves as a week planner for goals and subgoals.

■ *Day 3 – Using the 'ALPEN' method for Time Management*

This lesson provides various reasons time management is important: Proper time management can increase efficiency, while decreasing stress through clear planning of one's day. In addition, a concrete time plan removes the moment-to-moment decision making which often leads to procrastination. In this way, efficiency can be achieved with minimal willpower. As a method for time management, the 'ALPEN' method is introduced. A template for setting up a time plan is provided in the workbook.

A supplementary video recommends the free program 'Rescue-Time', which tracks digital time usage. The video serves as a tutorial on how to set up the program.

Week 2

■ *Day 1 – Procrastination types and reasons*
The results from the pilot survey are shown, giving the participant an impression of what other students report as reasons for procrastination. Different types of procrastinators are mentioned, as well as what situations promote procrastination. The corresponding workbook exercise lets the participant match themselves with a procrastinator type and allows them to note their personal 'time thieves.'

■ *Day 2 – Improving time planning*
The participant is encouraged to analyze their previous time plans with regards to gauging the time each task takes and their overall success level in achieving their daily goals. Reviewing previous time plans should allow for an iterative improvement of the participant's time planning skills.

■ *Day 3 – Reducing distractions*
The issue of multitasking is presented. With this, the 'Threaded Cognitive Theory' is introduced as a reason multitasking has such a negative effect on focus. Encouragement is given to remove the biggest distractor – the smartphone – from the work environment.

In a supplementary video, binaural beats are introduced as a method for improving focus.

Week 3

■ *Day 1 – Effects of procrastination*
The link between procrastination and stress and anxiety is shown. It is demonstrated what constitutes problematic procrastination. Different negative thought patterns regarding procrastination are exemplified. As a remedy, one should exchange negative thought pattern with positive ones. The first step to this is to notice when negative thoughts arise. The workbook exercise here asks questions on what thoughts are associated with one's personal procrastination.

■ *Day 2 – The 80/20 rule and the Pomodoro technique*
Participants are encouraged to incorporate the 80/20 into their time plan: Among other things – the 80/20 rule states that 80% of people's output results from merely 20% of their efforts. When someone finds their personal 20% (the time period where they find themselves most productive), it is recommended that they plan their day accordingly, maximizing work time in that period. Additionally, the Pomodoro technique is introduced as a method for splitting up work cycles into smaller pieces.

■ *Day 3 – Body, Mind & Procrastination*
Four topics are presented: Meditation, nutrition, exercise and sleep. The importance of each is highlighted while establishing a link between them and mental health and focus. Here, the participant is encouraged to watch the provided additional material for each topic. These include: A breathing technique demonstrated by Prof. Dr. Mrinalini Kochupillai from TUM, a TED talk on 'brain foods', a self-made workout video and a Youtube video on improving sleep. ■

Figure 6: Excerpt pages from the Proactivation Workbook

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Self-reflection

Starting the TUM: Junge Akademie project in 2020, our time was heavily influenced by the COVID-19 pandemic. In retrospect, this was also our biggest challenge. We met online for the first time and continued to work remotely for the majority of our project.

Despite coming from diverse study backgrounds, we decided on the idea for our project incredibly fast. We are all interested in the broader topic of health as well as the value of technology for a healthy life. So, when our team member Olli introduced us to his plan to tackle procrastination via a program, we were all very excited. After the kick-off weekend, we were joined by Elisa and Daniel – lucky us!

Soon, we also got to know our tutors, Saskia and Ho, and our supervisors, Prof. Dr. Ilona Grunwald and PD Dr. Dr. Alexander Zink. Ilona especially helped us a lot with our pilot study, in which we investigated the procrastination habits of about 800 students. The results showed an astonishing three-quarters of students who tend to procrastinate regularly.

While the tutors and supervisors were always available for questions and support, we were happy to build our project rather independently. Looking back, though, maybe we could have asked for advice more often, particularly regarding organizing our pre- and post-program surveys.

After a couple of months of working together, one of our team members, Anastasia, decided to leave the project due to time constraints. Of course, we were sad, but could understand her decision. Her absence, however, led to some serious time-scheduling trouble, since we underestimated the amount of work we would have to do to compensate for her leaving.

In retrospect, we should have considered this more. The video production especially caused a lot of stress in the group, even leading to some conflict regarding workload distribution and time manage-

ment. Fortunately, we managed to finish the videos and course on time and were able to resolve any tension within the group.

Despite working productively and sticking to our schedule, we all felt a decrease of motivation and connection to the project and the team after some time. This changed on our first offline weekend at the TUM campus. Working together in person for the first time gave our team an enormous motivational boost and brought us a lot closer together. Afterwards, we also started to meet in person for fun instead of work. A phase of hard work followed, including marketing our course and creating the content as well as the website.

Our second time mismanagement concerned our flyers for the "Ersti Woche" at the start of the semester. After disregarding the subject for too long, we had to power through two night sessions to design the flyers and two further stressful days to distribute them. However, we were very happy with the outcome.

On November 1, 2021, we launched our anti-procrastination course. Of course, we were thrilled that all the hard work had paid off and had resulted in the amazing program we had been dreaming of. Following this success, it was very hard to sustain our motivation, since we felt we had already completed the project. This led to yet another stressful phase in which we had to gather the surveys as well as to write the reports. In particular, getting our participants to fill out our post-course surveys led to some issues. Probably because our target group tends to procrastinate, the participation in our survey dropped massively compared to the pre-survey. We solved this by emphasizing the prospect of money for the first 50 participants to complete the surveys, leaving behind the idea of a follow-up survey after 6 weeks.

Taking everything into consideration, it is safe to say we were all able to learn a lot from our time at the Junge Akademie. Starting the project, we had no idea of the incredible journey that lay ahead of

us. Apart from some time management trouble, our biggest challenge was definitely the pandemic. It was incredibly hard to maintain motivation and connection to the project as well as to the group due to social distancing. Also, the weekend seminars being online for a lot of time was rather exhausting and we are sad to have missed the experience of the Junge Akademie weekend getaways. We are therefore looking forward all the more to the remaining weekends we have ahead of us.

In the end, we want to thank the TUM: Junge Akademie for this experience, connecting us students from different backgrounds and inspiring us to create our amazing project.

POSTER 1:

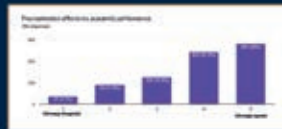During the Kick-Off weekend, Team Proactivation started its research on procrastination. After reading different papers and multiple articles, a pilot study was conducted. Roughly, 800 students took part in our survey and showed that many students struggle with procrastination. The results were shocking and very encouraging at the same time. But we quickly decided that we wanted to be part of a solution. We also asked the question: What tool do the students want to use? An online course, an app, or just regular Instagram posts. The app seemed to be the most convenient tool for the users but after a feasibility analysis, we decided to do an online course. With an online course, we were able to focus more on the content than the front end and back end. Soon after our decisions, we made a timeline and planned the whole project. Down below you can see what the actual timeline looked like. ■

POSTER 2:

In the summer, the team achieved its greatest progress. On the one hand, Team Proactivation started to concentrate on research. We designed a hypothesis that students have an issue with procrastination and the research question: To what extent does the three-week online course Proactivation reduce procrastination in students? We also decided to use the pre and post-model for our research.

On the other hand, we started to do the marketing. We created an Instagram account where we posted motivational quotes, facts, and memes multiple times a week. We also handed out flyers to first-years and prepared a slide for advertisements during lectures. The Munich Center of Technologies and Society also added Proactivation to their course catalog, which was a great acknowledgment for us. Finally, the website was almost finished and only needed some fine-tuning in the coming weeks. ■

POSTER 3:

Between the second and third poster, the website was finalized and the content was created. The three-week online course consists of nine main videos, which are mostly animated. But the course also consisted of additional material like a self-produced workout video and a mediation video. This time was very stressful because we had to meet the deadline for the release since the course needed to be available at the start of the semester. Luckily, everything worked out and the team managed to pull it off.
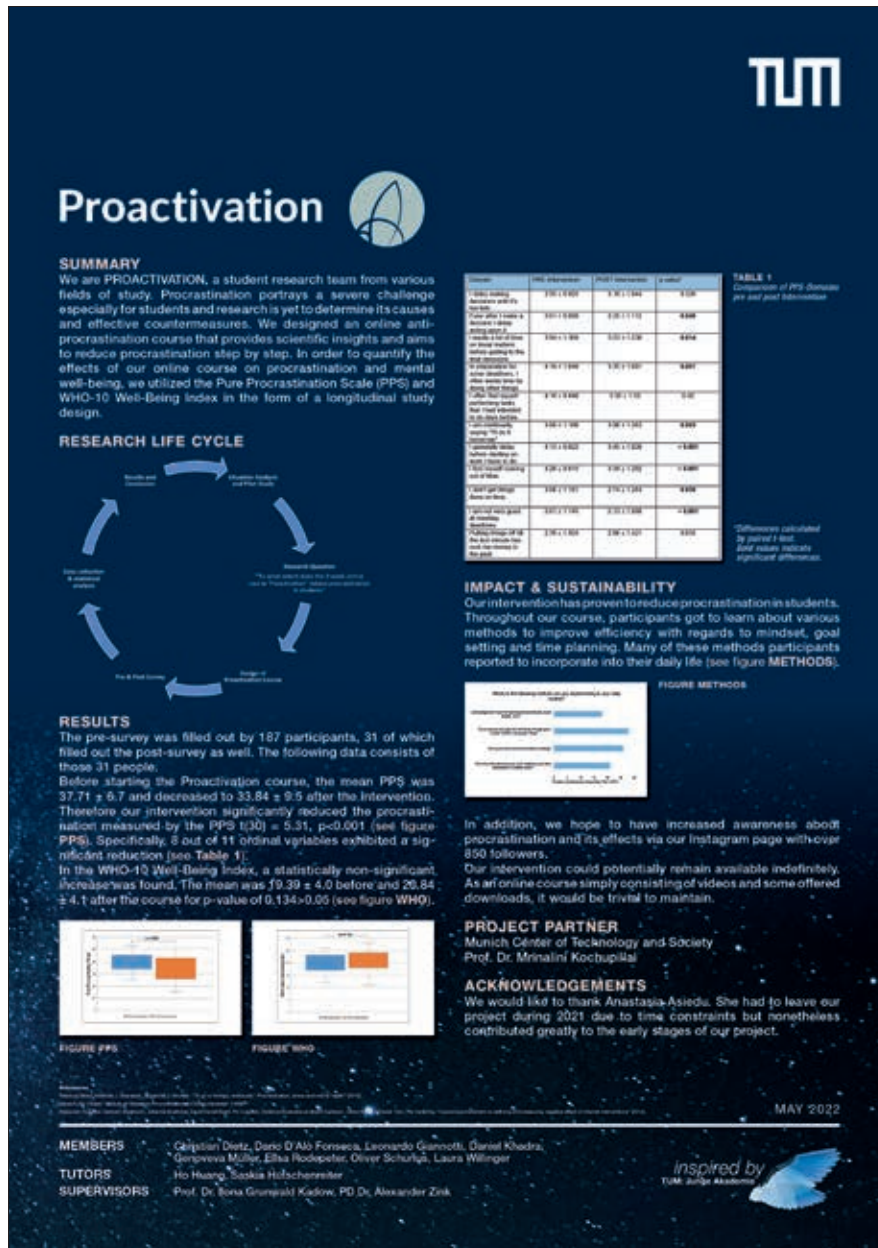
POSTER 4:

The last part of the project was to analyze the data. We are very happy that we were able to help our users significantly. Unfortunately, our sample size from the surveys is smaller than the number of people who started and finished the course. That was the biggest struggle for us – to get the users to respond to both surveys. Overall, though, we are very pleased by the result. ■

Highlights 2021

2020

NOVEMBER

The Kick-Off for class 2021 was held online on November 21-22, 2020. The scholarship holders formed five research teams under the call "Disruption & Reconstruction. Opportunities for global collaboration".

DECEMBER

On December 20, we celebrated an online TUMJA Christmas Party, organized by the Taskforce Event. The taskforce also brought to us our very own TUMJA Secret Santa. Every participant could enjoy both giving and receiving a small but meaningful gift from their Secret Santa sent by post. We unwrapped the presents together online.

Also in December, Taskforce Event organized the very first virtual Book Club Meeting. We were all quarantined, it was cold and dark outside – so how could one better spend the time than with an excellent read?

JANUARY
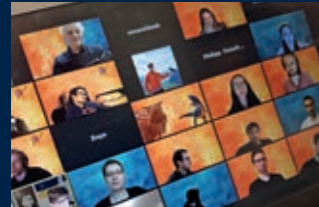
At their first Future Lab on January 30-31, 2021, the teams learned about project management and worked on their research question. The scholarship holders also joined one of the taskforces.

MARCH

Restarting our successful event serial "TUMJA Akademiegespräche", introduced first in 2014. In the first edition in 2021 Judith Gerlach, Bavarian State Minister of Digital Affairs, and Dr. Hans Pongratz, Senior Vice President at TUM for IT-systems (CIO) talked about digitalization: "Digitalisierung in Zeiten der Pandemie – Fazit nach Jahr Eins". The discussion was moderated by Annalena Huber and Deniz Bezgin, both scholarship holders of #class20.

APRIL
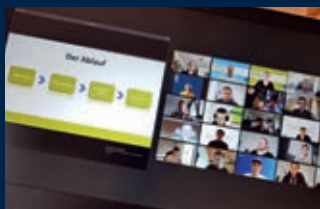
We joined forces with the Student Council of the TUM School of Management and the VMSI (Verband Münchner Studierendeninitiativen) to create one big student initiative event to connect and reach as many student initiatives and students as possible – the M!A, Münchner Initiativen Abend. The first virtual M!A took place in April 2021.
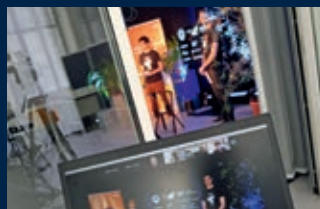
Science Hack 2021: "Sustainable & Inclusive Cities after the Pandemic" - eleven challenges were offered by six company partners and four TUM chairs.

MAY

Academy Talk with Verena Osgyan, member of the Bavarian State Parliament for Bündnis 90/Die Grünen, and Prof. Dr. Gerhard Kramer, TUM Senior Vice President for Research and Innovation, on "Forschung, Talente und Moneten". The discussion was moderated by Magdalena Bader and Mohamed Shoeir of #class20.
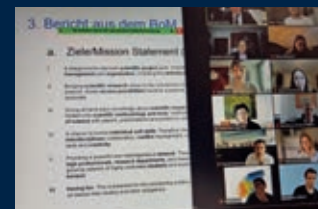
The TUMJA Advisory Board chose "Learning from Nature" as call for #class22.

2021

On June 25-26, we successfully launched the third #virtualTUMrun.

Virtual Information Event for Class 2022

Academy Talk with Wolfgang Huang, director of the Lindauer Nobelpreisträgertagung e.V., and Prof. Dr. Claudia Peus, TUM Senior Vice President for Talent Management and Diversity, on "Talente und Ambitionen. Von der Uni zum Nobelpreis". The talk was moderated by Katarina Mavroudi and Jeremias Widmann of #class20.

At the Intermediate Evaluation 2, the teams of class21 presented their projects and were coached regarding their project management and research. The second day included workshops for video production and graphic visualization.

OCTOBER

On October 30, 2021, we said farewell to #class20 at their inspiring and entertaining symposium "celebrate creativity". In their Research Reports 2020, the teams published the results of their project work.

Subsequent to the symposium, the scholarship holders of #class20 came together for their PAWE (ProjektAbschlussWochenEnde) at the Evangelische Akademie Tutzing, and finished their project work after the prolonged scholarship time of 23 month.

NOVEMBER

Kick-Off Class 2022: In November 2021, 40 scholarship holders started as #class22. They formed five research teams under the call "Learning from Nature."
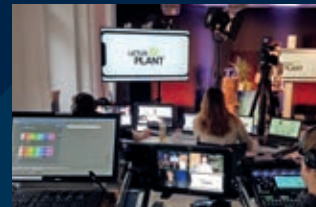
After the overwhelming success of the Science Hack in April, Taskforce CAP decided to run a second one in November on "Human-centered technology".

DECEMBER

Taskforce Event again delighted the TUMJA members with the "Secret Santa" event. The unwrapping of the presents took again place at the virtual "TUMJA Christmas Party @ home".

2022

JANUARY

Facing the last months of their scholarship, the teams of #class21 trained their journalistic and scientific writing skills at their second "Future Lab" on January 22-23. The teams also worked together on planning their symposium and learned more about how to illustrate their stories in a visualization workshop. The scholarship holders of #class22 focused on their project management skills in their first "Future Lab" on January 29-30.

FEBRUARY
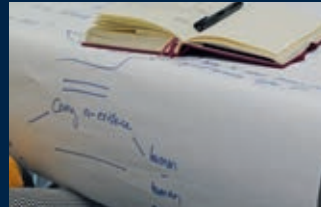
The first round of the "Cross Challenge" as cooperation between TUM and the three art colleges in Munich (HFF, HMTM, and ADBK) entered its fourth month. The sixteen participants investigated Caring Co-Existence in three teams with three very different approaches.

MARCH

Art Club in March: We visited the exhibition in Museum Brandhorst and attended a guided tour on "Andy Warhol and the dark side of Pop".

APRIL

With our pilot "Wordshop" we invited the TUM family – students, employees from science and administration, and alumni – to develop a short story, accompanied and advised by professionals. The seminar started with a kick-off weekend in Weimar and Leipzig, followed by several seminars from April to June.

The M!A 2022 took place on April 28.

MAY

In May, the classes 21 and 22 finally met again on-site at the Jugendherberge Dachau for the weekend seminars "Intermediate Evaluation 1 and 4". While the scholarship holders of class 22 further developed their project management and research skills, class 21 focused on the preparation of its symposium.

On May 27, 2022, the legendary TUM Dragoon Boat Race on Lake Olympia took place again! TUMJA joined with a team and won the third place in the category "costume".

JUNE

In June, we staged two well known events: TUM Campusrun – this year as a double feature with a virtual as well as an on-site run,

and the TUMJA Science Hack under the motto "Upgrade: Building A New Reality."

JULY

On July 2, 2022, the scholarship holders of #class21 present their findings at the annual TUMJA symposium.

Science Hack

A TUM: Junge Akademie scholarship offers the opportunity to get to know fellow students from various backgrounds. In keeping with this theme, TUMJA organizes the Science Hack, where students experience a unique weekend while working with fellow students on challenges provided by industry partners. Thereby, the Science Hack is a great challenge not only for the participants, but also for the scholarship holders who organize the event.

Having been fortunate enough to witness the organization of Science Hack 2021 – Season 1, the first online hackathon organized by TUMJA, we were confident that we could replicate the event's success. Therefore, we were determined to organize the Science Hack 2021 – Season 2 under the headline "Human-centered Technology." Having a clear path in mind, one task after another was completed, frankly, often on short notice. Due to spontaneous participant cancellations, we even had to extend the deadline for registration until after the kick-off event, which takes place one week before the actual Science Hack weekend.

When the main event finally started on a Friday in November 2021, 35 participants were eager to work on challenges posed by six companies and two professorships of TUM. Due to the easing of Covid restrictions, two teams were able to work on site. After giving a glimpse of their initial ideas in a first pitch on Saturday morning, the participants gathered all their remaining energy to finalize their projects by Sunday noon. After presenting their project results in a final pitch, our four-person jury, consisting of experts from academia and industry, determined this event's winner: Team *Wasserlassen*, which showcased an idea on how to keep employees hydrated while strengthening their sense of togetherness.

The Science Hack presented us as organizers with a major challenge, with many unexpected potholes along the way. However, at the awards ceremony, we realized at last that we had created an event enriching for everyone involved.

Christian Diez
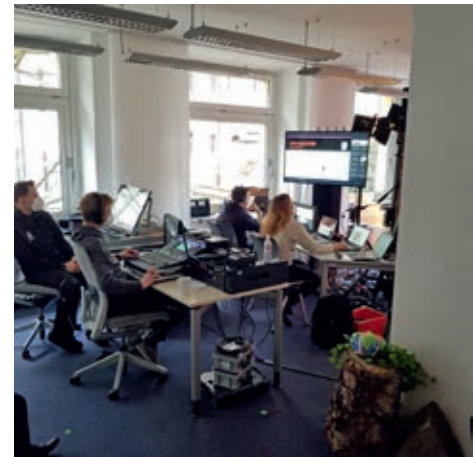
M!A

Until January 2021, TUMJA hosted the TdI (Tag der studentischen Initiativen) once per year in Garching. This get-together of student initiatives and students of all Munich universities was always a great success but, due to the Covid-19 pandemic, the last TdI in January 2021 was held online and turned out to be not as well attended as we had hoped it would. Yet giving up the concept was not an option for us, since we still wanted to provide an environment for students and student initiatives to network and to get to know each other. That is why we started to think about other ways to bring students and student initiatives together – and luckily we were not the only ones! Both the Student Council of the TUM School of Management (TUM SoM) and the VMSI (Verband Münchner Studierendeninitiativen) already had similar formats for student initiative events and contacted us about the possibility of organizing a joint event. We were all excited about this wonderful idea and immediately started the organization process for what would very soon become the Münchner Initiativenabend – or M!A. After our hugely successful first M!A on April 14th, 2021, with 36 student initiatives and about 180 students, we decided to keep the M!A alive and host it every semester on the first Wednesday of the new lecture period. This means that we had another M!A on October 20th, 2021, and our most recent event on April 28th, 2022. For the summer term 2022 M!A on April 28th, we used the same general format as we did for previous M!A evenings: in the first half of the event, each registered initiative presented their work in 90-second pitches in a public Zoom session, this time in a webinar format. In the second half, each initiative hosted their own Zoom meeting, which the student participants could attend to ask specific questions of their initiatives of interest. This format worked very well again, especially considering the total number of initiatives that participated: 38! This time, however, we worked together with a new partner. For the previous M!A events, we had cooperated with the VMSI and the Student Council TUM SoM. Unfortunately, the Student Council was not able to participate in the organization this term, but we hope that they will be able to participate in the organization of the M!A again soon, since we really enjoyed working with them. Instead of them, fortunately, the student initiative 180 Degrees Consulting Munich (180DC) volunteered to join in the preparation and presentation of the event! We are really glad about their spontaneous stand-in. And, as always, the VMSI was a pleasure to work with. We want to thank both organizing partners for their time and effort and are looking forward to the preparation of our next M!A with them!

For the next semester, we all hope to be able to host our M!A in person to have a more interactive event and reach even more students. Stay updated on our website for future information and save the date for our next M!A on October 19th, 2022. We are looking forward to seeing you there!

Magdalena Bader and
Catherine Yngaunis Koch

Campus Run

Since 2013, TUMJA organizes the yearly TUM Campus Run for the entire network of the Technical University Munich. The campus run goes back to the idea of the student research team runTUMfit, which hypothesized that simple methods could improve the fitness of TUM staff. Almost a hundred people took part in the first rounds, and the format grew quickly. In 2016, there were already 450, in 2017 more than 1,000, and since 2018 more than 1,500 TUMlinge taking part in the run. As a result of generally known contact restrictions, the first virtual campus run took place in 2020. And to our great delight, a total of 1,500 runners from all over the world attended this event.

Because of the success of the first virtual campus run, we planned a second one for 2021 with more features. The TUMJA office recorded a warm-up session with colleagues from the Faculty of Sport and Health Sciences and their student representatives in the Olympic Park. The broadcast was presented on the day of the run by the well-known moderation team "Saskia & Christoph," who were present at the joint start of the 52-hour event. This time, 1000 runners participated, including numerous professors, department teams, and TUMlinge teams. The winners were not only fast but also radiant, as the pictures at the trophy presentation show. Once again, the

runners from a total of 30 different countries participated with a lot of excitement, motivation, and enthusiasm.

The original idea of team runTUMfit
The team of 16 scholarship holders from class 2012 aimed to make students, professors, and employees of the entire TUM fitter because of their actions. The survey of the scholarship holders showed that the range of sports offered by the University Sports Center Munich (ZHS) was popular, but the distance to the sports facilities was often too much of a hurdle. Many students pointed out deficits in the sports facilities at the Garching campus and criticized the

Finally going out again!

3rd virtual TUM campus run
June 25th and 26th, 2021

#virtualTUMrun
ja.tum.de/campuslauf

hosted by

lack of healthy food offered in the cafeteria. In addition to the campus run, the team also planned the implementation of a blood donation day and the installation of a boulder wall. As part of the "Healthy University" day of action at TUM, the 1st campus run in Garching was organized and carried out by runTUMfit on June 13, 2013. Nearly 150 students and employees of TUM ran the 5.9-kilometer distance in teams or as individual runners. Many of the runners expressed the wish for a regular repetition of this event, which set the foundation for the now well-established event of the campus run.

The campus run in 2022 is expected to take place in a hybrid format. There will once again be the possibility to participate in the campus run virtually from all over the world. In addition, we plan to realize a run on-site at the Garching campus again. This campus run is supposed to take place at the same time as the GARNIX summer festival, on June 22, 2022, starting at 5 pm. The staff of the TUM: Junge Akademie office takes responsibility for and coordinates the event each year, with a small but highly motivated group of volunteers from the academy and beyond. In addition, many other people and institutions are involved, whom we would like to thank. In terms of logistics, we receive support from the ASTA Kulturreferat, the Studentenwerk Garching, and UnternehmerTUM, to name a few. The technical realization of the event would be impossible without the help of ProLehre-Medienproduktion, the company for our time measurements, and drone recordings by Mr. Hutschenreiter. To make sure that everyone knows about this great event, Uli Leyermann together with the TUM Alumni and Career and TUM StudiNews make sure

that the news gets spread. Among others, the real estate management of the location TUM Garching, the police Garching, the TUM fire department, and some paramedics of the BRK-Kreisverband Munich take care of the organization and safety of all runners.

The next campus run will hopefully be a great success again. We are expecting numerous motivated and enthusiastic runners on-site and online. In other words, my running friends, grab your running shoes, warm up, and save a spot for the next legendary excellent campus run of TUM: Junge Akademie!

Monica Déchène

TUM Art Club
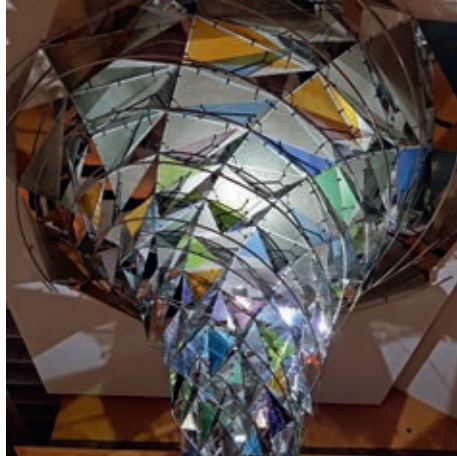
The pandemic and the challenging restrictions in personal encounters forced the TUMJA scholarship holders to come up with new formats for the social program. Online movie and gaming nights were born, and sweaty online workouts were held every Saturday under the guidance of TUMJA alumni from sports science. In the beginning, cultural events fell behind since theatres were closed and readings or concerts were canceled.

But scarcity can enhance creativity, and for some of our scholarship holders and alumni, this was the starting point to also think about new cultural formats. The initiators quickly realized that they would like to found a book club. The idea was well-received, and TUM students repeatedly met online to read books together, starting with The Little Prince. The online meetings to read together became a key moment during the pandemic.

The advertising for the events on social media drew the attention of numerous people, including Felix Maier, honorary professor at TUM SOT and director of the TUM choir and TUM orchestra. Spurred on by his enthusiasm, the scholarship holders and the TUMJA office came up with the concept of a TUM Art Club, which would encompass the fields of books, photos, music, and video. The Club aims at knowledge transfer, experience, and networking. The concept proved so persuasive that the Bund der Freunde der TUM agreed to fund a test run from summer 2021 to July 2022.

With the funding, we were able to increase the amount of video and photo equipment. Three sets with a camera, lighting, tripod, microphone and other accessories are now available. These are in use on an ongoing basis: in workshops organized by the
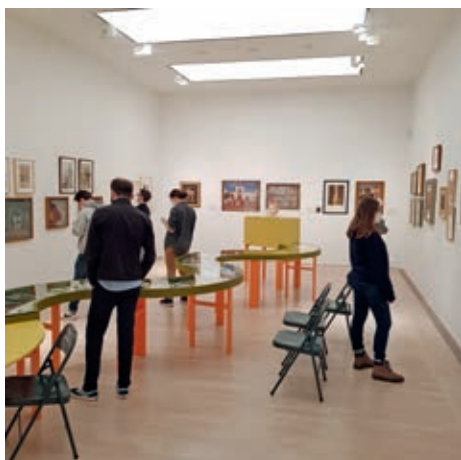
scholarship holders, with external trainers from the neighboring University of Television and Film, or during the weekend seminars, which have been on-site again since summer 2021. With lighting, filming, sound, and editing, the equipment covers all aspects of photo and video art.

In line with the call Disruption & Reconstruction of class 21, the concept was developed further and adapted in consultation with the Bund der Freunde. As a supplement to reading together, the desire to write texts arose. Under the title "Wordshops," four scholarship holders and alumni developed a three-month seminar in which twelve people from the TUM environment could participate. With the support of experts from the literary and publishing world, the participants developed their own short stories on the topic of "Unexpected Encounters." Twelve fascinating stories with exciting characters evolved. Without the idea of the Art Club and the support of the Bund der Freunde, these "unexpected encounters" in the network of TUM and TUMJA would not have been possible.

Special thanks go to Andrea Weiller and Magdalena Bader, who jointly initiated the proposal for the Book Club. And to Andrea Schittenhelm, Veronika Bader, Dennis Lehmann, and Nico Michel, who organized the "Wordshops" seminar with enormous enthusiasm and voluntary commitment. The final evaluation is still pending. We hope that the program will be continued and that we can soon share the literary outcome in a printed version.
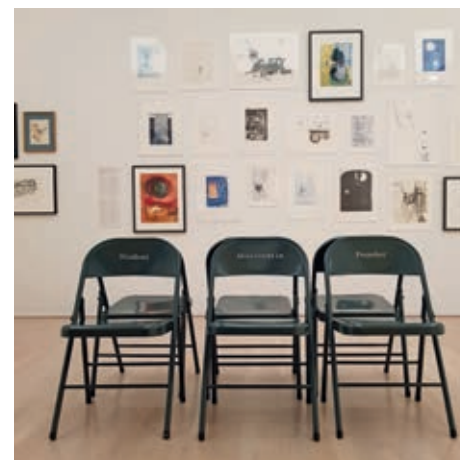
Peter Finger

Cooperations

Cooperations

Partner Universities

TUM: Junge Akademie is an initiative of the Technical University of Munich. In order to increase the interdisciplinary exchange beyond the manifold disciplines of TUM, additional universities from Munich have been invited to join the network since 2016.

"To further develop the Academy as a joint program of four very different universities turned out to be a valuable decision. Everybody benefits from the transdisciplinary interaction. Due to the evolved confidence and mutual understanding, we were able to start a new format in 2021: the cross-challenge."

Peter Finger
Managing Director, TUMJA

AKADEMIE DER
BILDENDEN KÜNSTE
MÜNCHEN

Academy of Fine Arts Munich (AdBK)

The Academy of Fine Arts Munich is one of the three artistic partner universities of the TUM: Junge Akademie and joined the network in 2019. Approximately 800 students are currently enrolled at the Academy of Fine Arts in Munich. Each student is assigned to a class of his/her choice, selected during the admission process. The Academy of Fine Arts Munich considers itself as an experimental laboratory and includes a total of 25 classes. Training at the academy focuses primarily on the development and practice of artistic skills and abilities in the fine arts. It also offers advanced degree programs in „visual design and therapy", „art and architecture", "interior architecture" and „art and communication". The talents of students are developed according to their major field of study and their personal interests. Curricula and teaching principles are based on self-reliance and personal responsibility.

University for Television and Film Munich (HFF)

Compared to the TUM, the "University of Television and Film Munich" (HFF) is a tiny school with around 350 enrolled students. However, the HFF is one of the oldest film schools in the world, founded in 1966, and is very successful as one of the premier film schools worldwide. The HFF Munich offers eight different degree programs: from directing to camera to script-writing. Emphasis is put on collaborating and storytelling through the medium of film with the help of world-class professors and teachers such as Prof. Julia von Heinz ("Und morgen die ganze Welt") or Maria Schrader (Emmy for "Unorthodox"). The school's illustrious alumni include Caroline Link, Doris Dörrie, Bernd Eichinger, Florian Henckel von Donnersmarck, Wim Wenders and Roland Emmerich. In 2011, the school moved to its newly purpose-built facility in the heart of the Munich art district. It continues to explore the medium of film and pushes the boundaries of the moving image, for example by creating a new VFX study program or researching AI and its possibilities for film.

University of Music and Performing Arts Munich (HMTM)

The Munich University of Music and Performing Arts is one of the largest universities in the cultural sector in Germany. It was founded in 1846 as the Royal Conservatory of Music and has borne its present name since 1998. The university offers more than one hundred different study programs in all fields of music, dance, and theatre, culture management, or journalism. More than 1.200 students from all over the world study at HMTM. The study programs prepare for artistic, pedagogical and scientific professions. In many fields of arts, tradition plays a very important role. The HMTM wants to keep the strengths of this tradition at the university. At the same time, new areas are developed like digitalization, digital art forms and questions of artistic research. Art develops best in an environment of free-thinking, experimentation, and creativity. Our university intends to be a creative laboratory for the students, professors and researchers, as well for the society.

New short-time Program: Cross Challenge

The TUMJA scholarship program not only aims at TUM students but also at those of the three partner universities. However, the 20-month scholarship period sometimes is at odds with the curricula at the artistic universities. In 2021, the Cross Challenge was launched for the first time to avoid exactly this hurdle by providing a shortened project period.

The joint trans-disciplinary project format between the TUMJA, the Academy of Fine Arts Munich (AdbK), the University of Television and Film Munich (HFF), and the University of Music and Performing Arts Munich (HMTM) is an experimental approach to identify and address complex problems of our present times in cooperation by different forms of knowledge and practice. It is more important than ever to develop unconventional analysis tools as well as alternative strategies of thinking and action that do justice to the current socio-ecological challenges and promote the necessary transformation in society. This is where the Cross Challenge comes into play.

Project outcomes can be artistic or documentary works, scientific essays or social interventions. They can take on a poetically descriptive, analytic, critically reflective or a politically activist orientation and can be a hybrid form that defy conventional categories. As a cross-university initiative, Cross-Challenge wants to promote trans-disciplinary research early on and especially the collaboration between scientists and artists, as we believe in its pioneering innovation and transformative potential.

A total of 20 students in higher semesters were invited to work in groups of 4-6 people under the overarching topic of "Caring Co-Existence". Over the course of four months in the winter semester 2021/22,

students with backgrounds in the arts, humanities, technology and social sciences developed their projects.

To realize their projects, the groups received a small production budget as well as professional input from international experts via workshops and lectures, accompanied and supported by lecturers of the partner institutions. Among the outstanding experts were the London based artist and designer Alexandra Daisy Ginsberg and the Brazilian architect and urbanist Paulo Tavares. In addition, representatives from each partner university were always involved: Dr. Su-

sanne Witzgall (AdbK), Daniel Lang (HFF), Dr. Tobias Reichert (HMTM) and Peter Finger (TUM).

The first public event of the Cross Challenge took place on October 23, 2021. Two lectures focused on the question of how to imagine and foster multi-species cohabitation in the face of "capitalist ruins" (A. Tsing) and a "damaged planet" (D. Haraway). An online panel discussion followed the lectures.

The enthusiasm of the participants was almost unstoppable. Therefore, the Cross Challenge was extended by one month.

There was an internal closing event on March 24, 2022. At this event, the participants had another opportunity to present their results and to reflect on the experiences and skills they had gained. A further event is planned for summer 2022, at which the Cross Challenge participants will be able to present their findings to a broader audience and the public.

Industrial Partner – Pixida Group

The Pixida Group turns digital transformation into sustainable success by combining the strengths of its members from strategy consulting to professional services to end2end products and solutions. We create customer value by developing new business strategies, innovating product portfolios, and utilizing cutting-edge technology.

With experience from more than 500 successful projects and 350 experts, we are focused on customer success and eager to shape the digital future together.

The international business scope consists of eight locations in Germany, the USA, Brazil, and China, a multinational team from more than 30 nationalities, and a well-established network of specialists and partners.

Pixida's continuous success is reflected by an average growth of more than 25% per year and multiple top-class awards. ■

Cooperation TUM: Junge Akademie

Since 2016 PIXIDA GmbH is a cooperation partner of TUM: Junge Akademie. Our experts in digitalization, Internet of Things (IoT), and mobility exchange knowledge on promising solutions for urban and public challenges with passionate students.

The relationship has been strengthened since the start of our cooperation in several ways: PIXIDA offers inhouse workshops, supports project teams to develop ideas into applications, and has participated in all Science Hacks organized by TUM: Junge Akademie so far.

In 2019 PIXIDA hosted the workshop "Smart Cities and Digitalization" for enthusiastic students. Urbanization has a major impact on society and the environment. The changes in urban areas cause new challenges and require innovative solutions. The workshop was focused on IoT applications within Smart Cities, an exemplary approach to measuring air quality, and an evaluation of blockchain cryptography.

The students visualized and discussed several IoT solutions and improvements through Data Analytics dealing with questions such as "Smart Cities and IoT – what does it mean?" or "How to use IoT and the cloud to make a city smarter." The final topic focused on "Blockchain – a broken chain of trust".

At the second edition of TUM Science Hack in December 2019 two student teams worked on the PIXIDA challenge on how to promote eco-friendly driving. Both teams developed Web-Apps to visualize the eco-friendliness of trips. The result was very impressive: both teams showcased live map visualizations, online sharing features, detailed trip details, and individual recommendations on how to improve eco-score.

From August 2020 to March 2021 several PIXIDA colleagues supported two TUM: Junge Akademie project teams in their ambition to develop mobile apps. Team TUMwelt developed an app to track individual urban mobility patterns with the goal to promote eco-friendly behavior among the young adult population. The focus of team AppCycle was on the re- and upcycling situation in the city. Shops & events, characterized by environmental awareness,

as well as the locations of recycling stations were supposed to be centralized within this application. The PIXIDA colleagues offered mentoring in the fields of functional development, architecture, data security, and design.

The topic of the Science Hack in 2021 was "The New Normal – Sustainable & Inclusive Cities after the Pandemic". The two PIXIDA student teams developed web apps to visualize the occupancy levels of public transport and pointed out the potential of PI Labs IoT Gateway as a prospering business case. The provided data consisting of WiFi probe requests by mobile phones were used to estimate the occupancy levels within public transport vehicles. The final concept for a passenger counting feature was showcased within a dashboard application.

This year, we have already participated in various events to evaluate further and new cooperation formats between TUM: Junge Akademie and Pixida. These included for example participating in the selection process of TUMJA scholarship applicants & mentoring one scholarship holder team during the initial kickoff workshop.

We would like to thank all the students for their high degree of social commitment and performance!

Let's continue our exciting and constructive cooperation in the future!

Taskforces

Taskforces

Taskforce CAP

Taskforce CAP manages cooperations between the TUM: Junge Akademie and TUM-external parties (e.g., companies/organizations). This is reflected in the acronym CAP which is short for "Contacts, Alliances and Partnerships."

In our work we focus on three main areas:

1. TUM Science Hackathon
The yearly TUM Science Hackathon is the largest event that we organize and host with partner companies, chairs, and 100+ participants.
For all Science Hack related topics, you can reach us at science-hack@ja.tum.de.

2. Pixida GmbH
Six years of partnership and trust (2016-2022)! In collaboration with Pixida, the company sponsor of TUMJA, we organize events where scholarship holders and Pixida representatives come together.

3. Partners of TUMJA
We also strengthen the network of TUMJA within TUM and extend it to further companies/organizations.
Collaborations can go from just one seminar or workshop, to supporting one of our project teams, to sponsoring TUMJA. We are always open for new partners and look forward to your ideas. Contact us at our Taskforce email contacts@ja.tum.de.

The three main areas of work aim to achieve two main goals:

1. Connecting
On the one hand, Taskforce CAP establishes and maintains a network and partnership with scholarship holders, alumni, and companies for the benefit of projects organized by TUMJA scholarship holders.

2. Fund raising
On the other hand, Taskforces CAP supports TUMJA by providing additional funds. This extends the range of opportunities of which fellows can make use for their projects, Taskforces, and seminar weekends.

As a scholarship program, TUM supports the scholarship holders academically. In other words, TUM provides funding for the academic-related activities like projects of scholarship holders and workshops. However, other expenses, such as for food and accommodation for scholarship holders, are not covered by TUM. This is where Taskforce CAP comes into play. TUMJA hosts on average two seminars each semester, where scholarship holders gather on weekends in locations around Munich to develop their project management and research skills. To allow all students to participate in these seminars regardless of their financial status, Taskforce CAP seeks to cover those expenses by securing external partnerships and sponsorships. Our major fundraising event is the TUM Science Hackathon.

Establishing and maintaining a network between scholarship holders, alumni, and companies through partnerships. TUMJA is more than just a 20-month scholarship program.
In fact, it is an everlasting network created from professionals coming from different backgrounds. To add value to this network, Taskforce CAP further expands it by engaging with a range of companies, turning TUMJA into a unique place for interdisciplinary communication with both alumni and companies. All parties involved in this interconnected network benefit from the exchange of innovative ideas and self-development. Since 2016, TUMJA is proud to have Pixida as a precious partner interested in supporting young talents. Besides keeping close ties, Pixida also sets up workshops for the scholarship holders and helps them with their

projects whenever possible. Taskforce CAP is responsible for managing the partnership with Pixida and aims to establish more partnerships that are similarly formidable.

TUM Science Hackathon. The Science Hack is a special event gaining increasing attention after each launch. In April 2021, Taskforce CAP organized the third Science Hack, which was held solely virtually and which turned out to be an overwhelming success. In this three-day event, companies and TUM chairs provide participants with challenges and tasks related to a specific theme. Participants from different backgrounds and academic levels team up to solve these challenges innovatively and gain exceptional experience. Moving beyond the Hackathon itself, participants are able to establish initial contact with possible future employers. Taskforce CAP is in the process of preparing for the next Science Hack in 2022 which will take place from the 26th to the 28th of June. Having previously received very positive feedback from both companies and participants, we look forward to building on this experience and welcoming another highly motivated group of partners and participants.

Team CAP. Currently, Taskforce CAP consists of five members from Class 2022 and one member from Class 2021. To ensure an improved experience for scholarship holders of the TUM: Junge Akademie, we collaborate with other Taskforces, especially Taskforce Marketing. Shout out to previous members who supported us with their expertise and best practices and are always there when we have any enquiries.

Class 2021
Christian Dietz
Maroua El Asri
Mohammad Hashem
Anita Kolmann
Philipp Patzelt

Class 2022
Ioan-Daniel Craciun
Pia Gutsmiedl
Emilia Litzka
Matthias Pixner
Lenz Pracher

Taskforce Event

Who are we and what do we do?

We are Taskforce Event of the TUM: Junge Akademie, an independent working group that focuses on bringing active scholarship holders, as well as tutors, supervisors, and alumni together. Our aim is to give all members of TUMJA the possibility to connect with people from different disciplines and cultural backgrounds to create networks across project groups and taskforces. By organizing a wide range of events, we provide the possibility to discover the unknown, broaden your horizon, have fun and enjoy your university life. Since the pandemic measures were relaxed, we have been able to organize in-person events again, which has been great for us as well as for all participants. During the winter, we also had online events to enable all scholarship holders to participate, despite being outside Munich or in isolation. However, we are excited to organize more in-person events soon and eagerly anticipate meeting all of you there!

How does it work?

As a member of the Taskforce Event, you decide what types of events you want to organize and which of your ideas you want to realize. Let your creativity run free! Moreover, you are in a strong team which organizes recurring events like the Munich's Initiative Evening (M!A) or the TUM Campus Run. Together with your ideas, contribution, and the support of TUMJA, everything is possible here.

M!A

Every summer and winter, on the first Wednesday of the new semester, we host the "Münchner Initiativenabend" (Munich Initiatives' Evening) together with other student organizations located in Munich. During this evening, Munich student initiatives present their work to students and answer their questions. If you're interested in getting to know a bit more about this event, feel free to have an extra look at pages 170-171.

Campus Run

One of the biggest events organized by TUMJA and Taskforce Event is the TUM Campus Run. Since the event was held in a virtual format in 2020 and 2021, and not as usual on Campus Garching, participants were able to join in from all over the world. As always, professors, employees, and students were able to run routes of 5.5 or 11 kilometers. Furthermore, participants were able to compete in teams as well. Many chairs or teams of five students participated in the TUMlinge challenge. To relive the spirit of an on-site campus run, the runners had the option of joining a livestream which started the 24-hour window in which to complete the run. Teaming up with a running-buddy was possible via a padlet pinboard. The virtual campus runs over the last years provided a great way of staying active and connected during the pandemic but we are now looking forward to meeting you in person in 2022.

Erwin Olaf

On behalf of the photo club, scholarship holders visited the exhibition: "Erwin Olaf: Unheimlich schön". The exhibition displays the Dutch photographer's art over the past 40 years and his development as an artist. First, everyone was able to walk through the exhibition at their own pace. Afterwards, the scholarship holders met the curator of Kunsthalle München, Anja Huber. She was able to give interesting insights into the work of Erwin Olaf and his photography. By intensively dealing with the art of Erwin Olaf, the scholarship holders learned a lot about the elements of photography, and how to convey emotions through photos. Visiting the exhibition was a success and inspired all participants to take further steps into photography.

Banksy

During the summer break of 2021, we created the Art Club, which started with a visit to the exhibition "The Mystery of Banksy" at the Deutsches Museum. Our visit to the exhibition was divided into three parts. First, we talked to the exhibition's manager, who gave us tips regarding what we should pay attention to during the exhibition. Then, we walked freely through the installation. Lastly, after our tour, we met the manager again to discuss our impressions and ask questions regarding Banksy's work. It was a very enriching experience!

Lange Nacht der Museen

After our visit to Banksy's exhibition, we continued our Art Club by attending the "Münchner Lange Nacht der Museen" (Munich's Long Night of the Museums). During this night, we networked with other scholarship holders and visited several different museums at the same time. We saw everything – from a party at the BMW Welt to a historical MVG bus which was being driven through the city!

Ice Skating

One of our activities in winter was ice skating at the Olympiaeissportzentrum (Olympic Ice Sport Centre). It was the first chance for this year's scholarship holders to meet their team and other members in person. After multiple online events, seeing each other at the ice rink was a great change. Everyone enjoyed each other's company and we had a lot of fun. We are looking forward to going ice skating next winter.
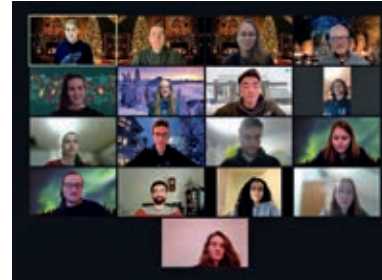
Secret Santa

"It is the most wonderful time of the year" – except that it was not, because the pandemic prevented us from seeing each other and celebrating the festive season together. Luckily, the elves of Taskforce Event organized the Secret Santa event. Everyone could spread Christmas cheer and let out their creativity to make a meaningful present for another TUMJA member. Finally, the gifts were unwrapped at the TUMJA Christmas Party @ Home, where we enjoyed a delightful and festive evening.

Christmas Presents

One of our main goals as Taskforce Event was to have a Christmas party in person to close 2021. After realizing that this wouldn't be do-able, we decided to shift our focus to preparing Christmas presents to the scholarship holders. By doing so, we were able to deliver the Christmas spirit in the form of Spekulatius, Lebkuchen, chocolate, and tea to all members of the TUMJA. We even prepared vegan, gluten-free, and/or lactose-free packages to include everyone!

Christmas Party @ Home

After the unwrapping of the Secret Santa presents, we started our short but beautiful Christmas event. Our highlight was the Christmas story read by Peter, the director of TUMJA.

Class 2021
Daniel Khadra
Nico Michel
Valentin Roth
Catherine Yngaunis Koch

Class 2022
Leon Dorscht
Sophia Duggen
Miguel Marcano Bethencourt
Alexander Sobieska
Steffen Wedig

Taskforce International

The Taskforce International makes its long-awaited return with Class 22. After a tumultuous ride through the pandemic, a new team has taken the lead. The current taskforce will continue the work initiated by previous generations while at the same time starting new endeavors. The team remains committed to establishing connections between the international community and the Junge Akademie. However, do not let the term 'International' mislead you! The Taskforce International, now more than ever, is working on spreading the word about the TUM: Junge Akademie and will also act locally to promote the scholarship program.

The very first project in the books is a collaboration with New Mexico State University. Dr. Sabine Hirschauer from the department of government (NM State, USA) and a group of students will visit our university during the first week of July. The Taskforce International is organizing an event at the Amerikahaus München. There will be a podium discussion, presentations and many other activities. This will be an unprecedented opportunity to discuss the international setting of our university life, migration and cultural exchange.

Further along the road the Taskforce International will be coordinating the Falling Walls Lab (currently planned for the Winter Semester of 2022, Garching). Falling Walls is a unique international platform for leaders from the worlds of science, business, politics, the arts and society. Students and alumni from around the world will present their solutions to the greatest challenges of our time. More information will be available soon, and the exact date will be announced.

The cooperation with the Imperial College London will resume starting with the long-lasting Summer School. The project ultimately failed because of the pandemic. However, with things returning to normal, the TF International is working harder than ever to bring back to the forefront one of its most anticipated exchange programs.

Along with the Summer School, more collaborations with the Imperial College of London are planned as the Taskforce International uncovers its plan. Among which, a Student Initiative, which will greatly facilitate in the long run any other projects and collaborations with the ICL.

However, the greatest challenge remains local and not global! Everyone at TUM should know about the TUM: Junge Akademie, and that is now part of the Taskforce International's duties. At the dawn of a new era, the taskforce is more than ever part of the TUMJA. Its greatest ambition? Think global, act local.

Class 2022
Mohamed Zied Jaber
Sophia Maria Rebecca Leiß
Valentin Pauli
Constantin von Witzleben
Julius Johannes Wenzler

Seniors
Mohamed Shoeir
Nina Zuber

Taskforce Marketing

We, Taskforce Marketing, aim to make the TUM: Junge Akademie more visible to students and employees at TUM, as well as to potential partners and employers outside of TUM. This requires us to be in close contact with the main office and other Taskforces to coordinate our activities. From building social media contents to creating concepts for branded TUMJA merchandise – Taskforce Marketing is responsible for raising the public profile of TUMJA through strategic campaigns.

With the ongoing Covid-19 pandemic, our efforts were mainly online-focused. We created campaigns to promote TUMJA offline events – or their virtual counterparts. For example, we worked together with Taskforce CAP to promote this years' Science Hack. Furthermore, Taskforce Marketing is not only responsible for the TUMJA merchandise catalog, but also designs smaller branded items like postcards and flyers that help to continuously raise awareness of TUMJA. In general, our work expands the borders of our own Taskforce. For example, we closely collaborate with Taskforce Event in order to help them promote their events, work together with Taskforce Symposium to promote the TUMJA Symposium and represent the Junge Akademie on yearly events like the IKOM.

Our members come from various fields of study – often without a background in marketing. However, this does not impact our performance: together as a team, we come up with creative ideas for promoting the TUM: Junge Akademie. Creating new and exciting solutions is essential to our task. For our taskforce, it is not necessary to be an expert with professional design tools, but simply to exhibit a general creativity and an interest in helping TUMJA grow its reach.

Our Taskforce has a lot of freedom when it comes to conceptualizing and implementing projects. Also, new members have the opportunity to lead their own projects and to experiment in the field of marketing. We aim to offer hands-on experience to each of our members, no matter if he or she wants to learn new skills or apply their existing skills with us. The wide range of our work gives everybody an opportunity to find a task that best suits their abilities. Students aspiring to join Taskforce Marketing will thrive by facing these challenges with enthusiasm and creativity.

Finally, we are responsible for conducting interviews with TUMJA alumni. In the past months, we have had the pleasure of interviewing Dr. Cora Uhlemann, who is now an assistant professor for theoretical cosmology at Newcastle University, as well as Prof. Dr. Matthias Geuß, who recently started a position as a professor for embedded systems at Hochschule Coburg.

Class 2021
Eva-Madeleine Schmidt
Oliver Schurius
Tobias Tiemeier
Josephine van Delden
Niclas Weddingen

Seniors
David Noachtar
Elena Tangocci

Class 2022
Aastha Chandiwala
Manfred Klemt
Julius Maximilian Miers
Seong-Min Jun
Christina Schwalm

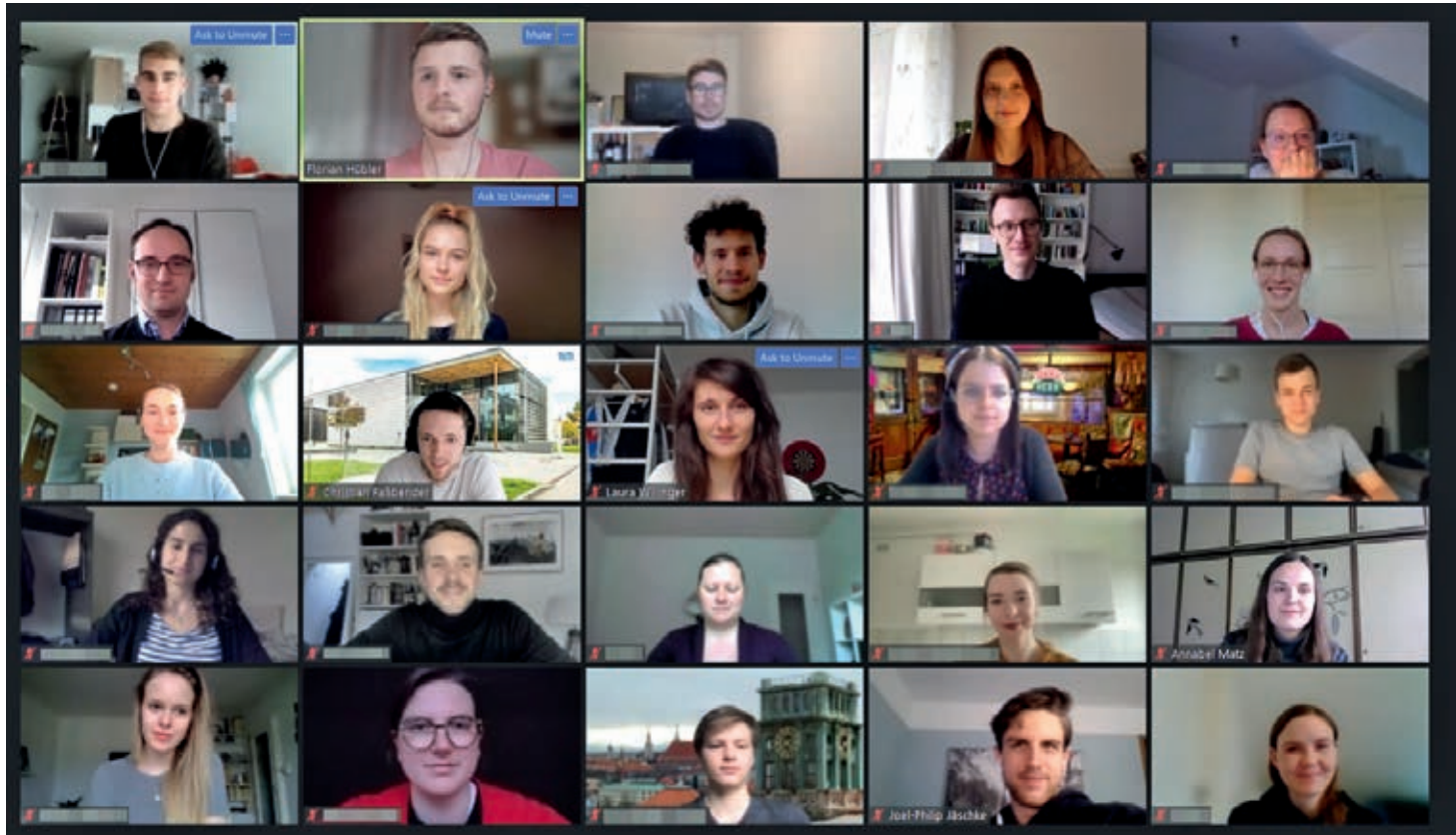The following pictures give some impression of our work from the past few months:

Interview with Dr. Cora Uhlemann

Interview with
Prof. Dr. Matthias Geuß

Taskforce Mentoring

The Taskforce Mentoring designs a mentoring program for current scholars of the TUM: Junge Akademie. We are convinced that mentoring offers great benefits for both sides and is a valuable part of the curriculum of the TUM: Junge Akademie. Our program offers the opportunity to establish personal contact between scholars and alumni of the TUM: Junge Akademie. In this way, individual advice and inspiration can be passed on from experienced alumni to younger scholars. At the same time, mentors can keep in contact with their alma mater and benefit from the next generation's knowledge and enthusiasm.

The third year of our mentoring program is currently underway. We are pleased that 48 alumni have agreed to volunteer as mentors. They provided information about their study background, their LinkedIn or XING profile and certain personal circumstances. In addition, 20 scholarship holders were interested in becoming a mentee. Since we assume that the mentees themselves know best with whom they would like to exchange with, they were able to rank the potential mentors, and a matching tool calculated the resulting tandems. In May 2021, we organized a virtual launch event on ZOOM to kick off this year's mentoring for 19 new tandems. It began with a presentation of the program and its framework conditions, such as the tandem agreement. Here, both parties record their expectations and organizational arrangements. Since the event also served as a closing event for last year's tandems, they were able to tell the newcomers directly about their experiences with mentoring and provide further insight into their interaction. All in all, the event was a great success with lively conversations continuing late into the evening.

The tandems shape their interaction very individually: although mentor and mentee are expected to meet at least three times during the one-year duration of the program, the frequency as well as the location and the topics discussed are determined by them. Both academic issues and personal topics can be covered.

In addition to the kick-off, our interim meeting was held in November, when we spent an evening together at the Augustiner-Keller. Because of Covid it turned out smaller than planned, but it was still a nice get-together with good food and great conversations. In December, we had the pleasure of interviewing Prof. Geuß together with taskforce Marketing for the newsletter of the TUM: Junge Akademie.

Together with our five new motivated members from the class of 2022, we are preparing the mentoring program for this year. We are also working on involving TUM professors and Emeriti of Excellence as mentors or in other ways.

We are looking forward to performing the next steps. Stay tuned!

Your Mentoring Taskforce

Class 2021
Musa Altun
Dario D'Alò Fonseca
Alexander Holas
Adrián Löwenberg Casas
Annabel Matz
Laura Willinger

Class 2022
Nina Dieminger
Til Hagendorn
Wenxuan Li
Kathrin Schmalzl
Ipek Tuncel

Taskforce Recruiting

We, the Taskforce Recruiting, are responsible for selecting the most motivated students for a new scholarship year.

To be able to recruit new scholarship holders for the TUM: Junge Akademie (TUMJA) on a yearly basis, our work begins with the nomination of talented students. Therefore, we are in close contact with the individual departments to identify the best percent of all students. On average we nominate 10% of students across all TUM departments. These are the students who are nominated by us and Prof. Müller for TUMJA.

Another part of the application process involves planning and organizing three information events for interested students. Here, we give the students the opportunity to meet active members and gain first-hand insights into TUMJA. Due to the current situation, we hold the online information events via Zoom.

We then proceed with the application phase during which we evaluate the incoming applications of potential scholarship holders based on predefined criteria. Here, the applicants' personal motivation and ideas regarding the call are the most important ones. Of course, we always aim to ensure an objective and unbiased evaluation of the applicants. Last year we went even one step further: the applicants had to anonymize the letter of motivation, the CV and the essay/video. This ensures that we can rule out unconscious influences on our decision-making. The first feedback on this improvement was positive, so we decided to continue with it.

Last but not least, we are responsible for organizing the selection days. During these two days, the applicants are asked to participate at various individual or group tasks, such as presenting their proposed project ideas described in the essays, or having an interview with other scholarship holders, tutors, or supervisors. This year we want to establish a new scoring system, as academic marks (1.0, 1.3, etc.) seem no longer appropriate. This new score should facilitate the comparison of the applicants and helps in assuring that the selection process is fair and replicable. Accordingly, based on this performance, about 40 to 50 students are chosen to participate at the TUM: Junge Akademie.

Finally, the winter has come, the die is cast, and we can lean back and bathe in our success …

Of course, we don't lay low during the winter. We are often in contact with other taskforces and try to help where we can. For example, together with Taskforce Event, we organized a get-together for class22 at the kick-off weekend.

The greatness of a community is most accurately measured by the compassionate actions of its members. We are proud to be able to contribute with our work to actively shaping the unique and excellent atmosphere of the TUM: Junge Akademie in the future.

Class 2021
Giannotti, Leonardo Marco
Prendi, Alesia
Reh, Sara-Luisa
Schittenhelm, Andrea
Thieme, Wolf
Wiehe, Luca Mattes

Seniors/Mentors
Bauer, Veronika

Class 2022
Gentner, Laura
Loferer, Tobias
Schnack, Lucas
Villard, Benjamin
Winkler, Corinna

Roadmap

As every year we are looking towards our major milestones. At this point, the new students have already been nominated and are registering for the information events.

Throughout summer we will accompany them all the way to their final acceptance in the Junge Akademie.


Anonymity

For the second time, we ask our applicants to provide their applications in an anonymized form. This means that no names or pictures should be provided. Even for the videos we ask applicants to avoid filming or recording themselves, to make the process more objective and fair.

4000 Nominierungen aus 38581 Studenten gesamt
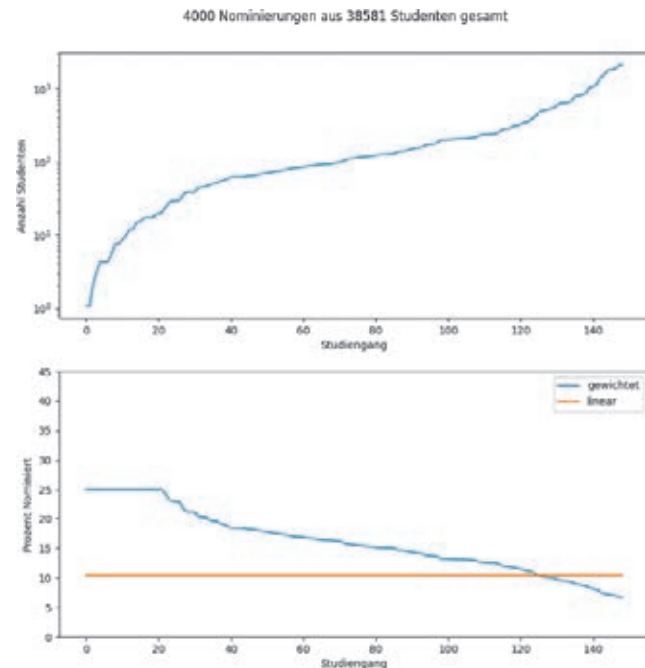
Nomination Percent

Last year we automated the nomination percentages for the different departments. We use different percentages for interdisciplinarity, but still want it to be as fair as possible. This year, we try to differentiate by study courses, not just departments.

Taskforce Symposium
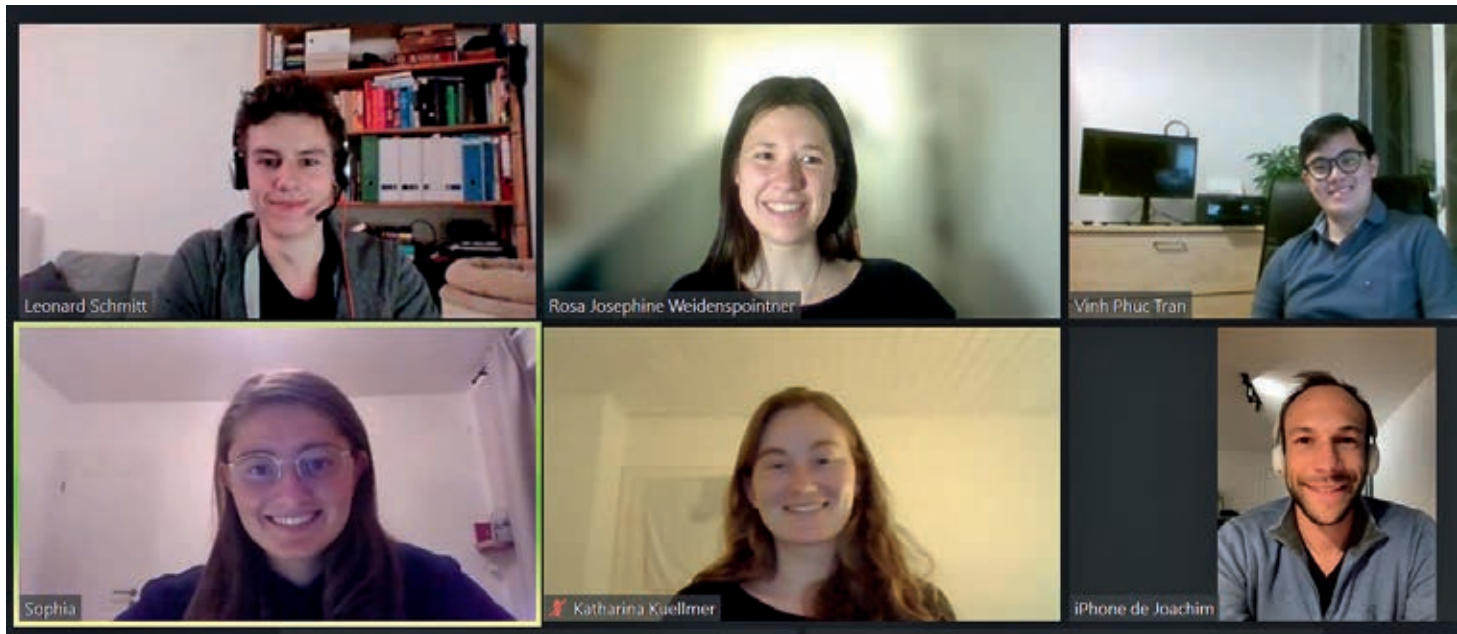
Established in 2019, our taskforce (TF) has one single but important task: to organize the yearly symposium, the grand final event of each class of TUMJA. In ancient Greece, the symposium was the part of the evening after the meal when people would drink together while enjoying music, dancing, recitals, or conversation. Nowadays, it refers to an academic conference, and our symposiums here at TUM-JA hopefully combine the best of both worlds, embedding scientific presentations in a generally enjoyable and entertaining program.

We only have this one task – but it's a big one. To make the best out of this event that brings into focus the projects of the individual teams and the yearly call, our TF has full creative freedom. Except for financial and physical limitations, the sky's the limit. Ideally, first ideas regarding the nature of the symposium should be gathered a year beforehand, and an overall concept should be agreed half a year before the big day. Over time, this concept is perfected until ultimately, every minute of the event is carefully planned out.

For that, close cooperation not only between the TF members of both classes is needed, but also with the project teams, the other taskforces, and many external parties. In our case, we (class 21) developed first ideas of how we wanted the symposium to go down, but quickly got help from the new students from class 22, with whom we now elaborate all the details. This year, they'll help us organize our symposium, thereby learning how to do theirs next year, and then teach the following class – hopefully making each symposium even better than the last one.

At the same time, collaborating with the other taskforces is crucial to making the symposium a success – from marketing (TF Marketing) to sponsoring (TF CAP) to planning the after-party (TF Event).

And of course, we need to be in constant dialogue with the project teams, to factor in their wishes and hear their difficulties in contributing to the event. Aside from these internal communications, we need

to work with numerous external parties – caterer, keynote speaker(s), sound technicians, financial partners – as all of those, and more, need to be involved. Here, the previous class and our TF senior, Paul Sieber, help massively in telling us which partners the TUMJA had used in symposiums past. As should be clear by now, organizing such an event is no easy task, so it's a good thing we can hire a professional event management coach, Markus Walsch, to help us out – which we did. The designated moderators, in our case both from our class, can also profit from moderation training by Jürgen Puls.

Our year's call is "Disruption and Reconstruction – Opportunities for Global Collaboration", but with this broad a topic, no team really addressed the whole picture. However, most teams worked on projects related to the students' experience of university. Since that's something that concerns and interests all of us, we chose the topic "The University of the Future" as main theme of our symposium. The event will take place in the afternoon of Saturday, July 2nd, 2022, in the Audimax of TUM. In the first part, the guests will get the chance to develop ideas for further applications of the teams' findings in short workshops. After a food break, the evening program of the symposium will begin, where the results of the projects will be presented, and a speaker will share a vision for the future of universities.

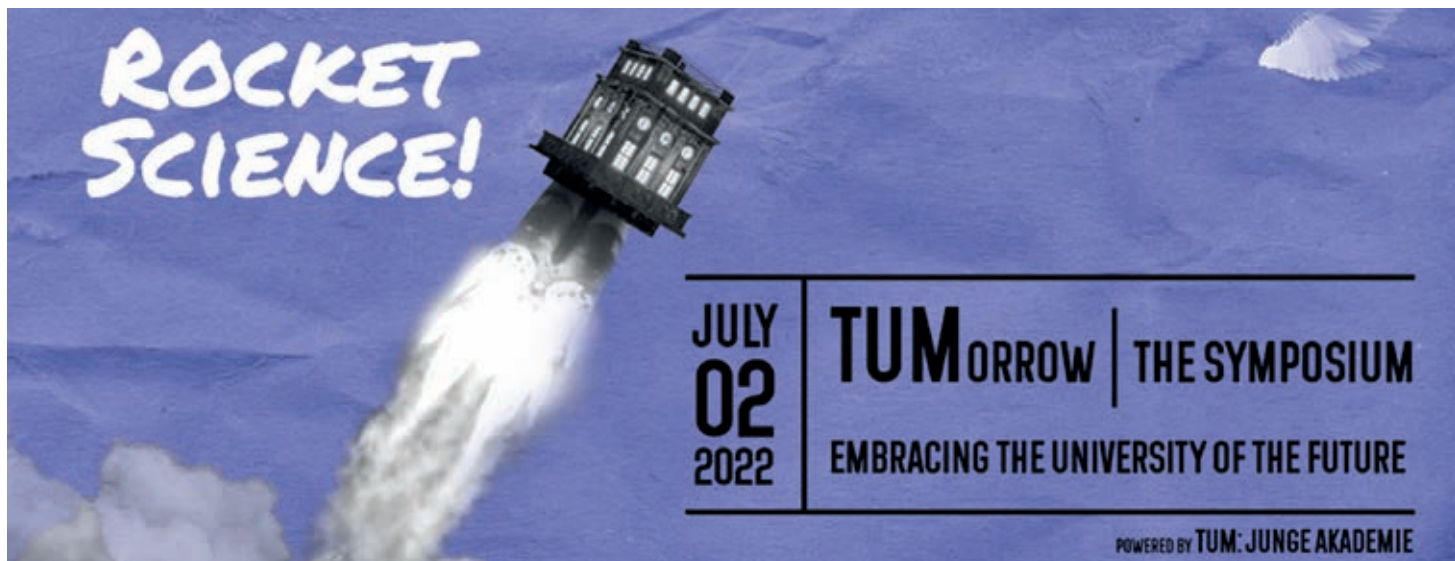We can't wait to welcome you to this year's symposium! Stay tuned and see you on July 2nd!

Class 2021
Alix Bertrand
Marlon Demandt
Joachim Leibold
Genoveva Müller
Elisa Rodepeter
Anna Sophia Schmid
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Class 2022
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Vinh-Phuc Tran
Rosa Weidenspointner

TF Senior
Paul Sieber

ROCKET SCIENCE!

JULY 02 2022

TUMorrow | THE SYMPOSIUM

EMBRACING THE UNIVERSITY OF THE FUTURE

POWERED BY TUM: JUNGE AKADEMIE

Taskforce XP Transfer

Imagine being a time traveler and you decide to travel back to the ancient Roman Empire. Despite being so long ago, you might be impressed by the many achievements they had; be it well-organized and clean cities with sewerage systems, or such seemingly simple things like being able to bake tasty bread. Now, let us travel forward in time by some centuries – we end up in the European Middle Ages. You are curious to observe all the progress that humankind has made within these centuries, but what's this? People now just pour their drain water right on the streets, and delicious bread of previous civilizations has changed into loaves of bread so hard, they might as well be used as hammers.

What happened? The Roman Empire dissolved, and, with it, a lot of knowledge and experiences just disappeared.

Transfer to TUMJA

Let us now travel back to the present age and take a look at the TUM: Junge Akademie. A group from the current year might struggle to construct a well-made survey and wonder how to get enough participants. Of course, the group members are smart and search the project books of former years for information, where they find several surveys that were carried out previously. They even find members of those groups that are still active within TUMJA. But a lot of time has passed since then and they sadly do not remember the necessary details.

Another group might just have started to get in contact with partners and want to use their group's shared mailbox. The TUMJA office has sent them a two-page-long instruction and the specific "CN-Funktionsobjekt" they should use. Nevertheless, they fail a couple of times to include this mailbox to their mail clients – until one of them figures it out and explains the way it works to the others on half a page.

The time traveler smiles a bit – the situation has not changed a lot over the course of history: People are still acquiring a lot of know-how and experience, some of which sadly gets lost along the way. Wouldn't it be great to have a central pool of information and to be able to have this half-page tutorial about how to set up the shared mailbox? Or, even more awesome, to find another short article about the main lessons learned by the former groups that created a survey?

Intro and purpose of Wiki

The Taskforce Experience Transfer (XP Transfer) is exactly targeting this issue.

We aspire to provide a platform where people can go to find solutions. This is meant to help people accomplish their tasks better and more effectively within their project groups and taskforces.

We use the TUM Wiki as the platform of our choice, which is a Wiki system based on Confluence. The Wiki is a webpage, where each member of TUMJA can log in and create new (or edit existing) pages within a tree-like structure. Working with a single page in the Wiki is quite easy because the page editor works in a "what you see is what you get" way.

Today, many groups and taskforces already work with the Wiki to some extent: Lots of agendas and protocols can be found along with several pages where people discuss how to proceed. In addition, many pages containing valuable know-how can be found within the Wiki.

Plans from the TF

This is the exact point where the Taskforce XP Transfer comes into play. We have created a more sustainable structure within the Wiki to have a framework for transferring know-how and experience.

The first issue we tackled was to create a clear tree-like structure where people know directly where to search for solutions. At the top level, this means a division of Wiki contents into the project phase, taskforces, tutor experience, TUMJA office and IT. This should prevent cluttering through too many pages just being saved at one point because people didn't know how to properly save a new page. Therefore, we introduced a "Wiki Cleanup Day", where the taskforces had the chance to look through their old articles to sort out any irrelevant ones and to order the rest in a sensible way.

As a second step, we created easy-to-use templates and guidelines for creating a page. This is to make pages more uniform and also lowers the threshold to create a new page. For example, it is often more helpful to have a brief summary of all relevant points in a bullet point form than having multiple pages of running text; compare this to the previously mentioned setup of shared mailboxes.

In addition to the tasks related to knowledge management, we try to push forward tools and technology which can be helpful for
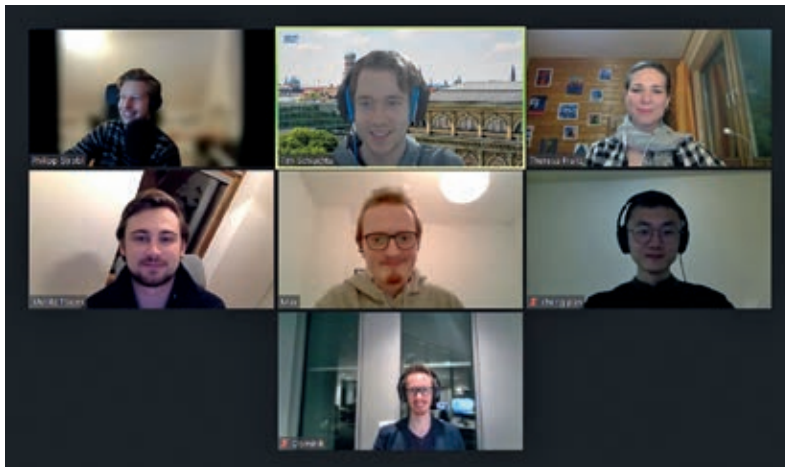
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Tim Schlachta
Philipp Strobl

Class 2022
Maximilian Hampel
Cheng Pan
Moritz Ptacek

Senior Member/Founder
Dominik Irber (Class 2013)

TUMJA. For example, we implemented an intuitive calendar for the TUMJA Wiki, which can be exported into your personal Google calendar application.

Our third main objective is still ongoing: to find new, relevant topics and to write articles addressing them. These should serve as examples and inspiration for other people to write new pages – and, of course, the pages should be useful by themselves for others. A particular focus of the first articles was the Wiki itself; despite many TUMJA members already working with the Wiki, the majority of them just didn't utilize its full potential. For example, a lot of users did not know how to create a new page from a template.

We focused on these initial problems at first because it is extremely important to introduce new tools and ideas properly and to communicate the chances and challenges in a clear and concise manner. Otherwise, people might experience frustration at a very early stage and falsely deem the Wiki to be a poor system.

To highlight this importance, let us take a quick look at Munich city hall. They shifted their IT infrastructure from Microsoft Windows to a Linux-based system. For computer-savvy people, this is no big deal, as Thunderbird is very similar to Outlook, LibreOffice Writer similar to Word, and so on. However, for the common user of these programs, there is a difference. Trying to adapt their existing knowledge to a new framework might fail because things have different names and are located in a different place within the programs. These are not severe problems, but without proper introduction, hundreds of people have to search for the same things and get frustrated. This is of course a simplification, but in the end, the general frustration was so high, that Munich shifted back to Microsoft Windows – causing even more costs for changing a main component of their IT infrastructure.

Now, back to Taskforce XP Transfer. After a general structure has been established and first pages are created, we introduced the Wiki and the newly created chances to all the other taskforces and groups. At a very early stage, they should experience the benefits of a Wiki filled with helpful information and experience, and in turn be motivated to share their experience with the community of TUMJA. Among others, we currently introduce the Wiki to new scholarship members in a welcome e-mail, highlighting the most important articles and features of the Wiki and additionally offering a video-on-demand tutorial online.

Outro

Our time traveler is curious how it worked out and travels a bit forward in time. He is quite happy to see that TF XP Transfer no longer exists because each member of TUMJA searches the Wiki first in case of problems and updates the page after their group performs the task. If necessary, they even create a new page to save the experiences for the next generation, therefore making the Taskforce redundant. The time traveler realizes that this Wiki-based solution works in this case. As he takes a look into a history book, he notices that the ancient Romans also had a kind of Wiki to save know-how – so-called "libraries."

Projects in Prospect 2022

We at Team Aesthetics are convinced that additively manufactured prostheses will replace conventional ones at some point. Our aim is to develop a customizable and aesthetic prosthesis that will be able to adapt to the individual dimensions and needs of every potential user.

Our Goal a smart prosthesis

Additive manufacturing makes it possible to produce components of prostheses in larger quantities and with a high degree of customization. In medical technology this offers the advantage of providing patient-specific solutions and thus increasing user-friendliness and acceptance. Furthermore, with this new manufacturing method it is possible to produce highly complex geometries, topological and weight-optimized components or geometries that could not have been produced with conventional methods. There is a wide selection of materials (from different types of plastics to nylon) and individual processes available (such as basic extrusion or even selective laser sintering). These degrees of freedom create different component properties. We want to assess our findings on existing finger prostheses and develop our own functional prototypes. Initial ideas already make use of the independence of joints and kinematics and aim to be as user-friendly as possible. We are trying to produce the prosthesis from a single component and make it individually adaptable. For the time being, the focus is on prostheses made of an elastomeric material that are preferably manufactured in PBF/LB-P or MJ, whereby the first obstacle is the resolution limit of the processes.

Main functions

- Individual joints

- Additional kinematics

- Fine personalized structures

- Reduced number of parts

In the early phases of research rounds, we have classified the technologies we need for replicating the finger into 3 categories, based on the function they must perform:

- JOINTS, because the finger has to be able to bend itself approximately a biological finger does

- SUPPORT, for the user to be able to perform normal day to day tasks, the finger must be "grounded" stiffly, such that it supports the reaction force its surface is supposed to.

- SENSORIAL, we need a design that is either able to replicate the texture and feel of the real finger or a design that does not look out of place when worn.

Team

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CheckMate

Who we are – Team CheckMate

Let us introduce ourselves and our project! We are a group of motivated students with diverse academic backgrounds.

Our goals

To develop an interactive tool:

- that indicates whether one is able to distinguish fake news from real information, based on the answers of the person conducting the test

- that is tailored to information and fake news from the area of social media

- that increases media literacy of high-school students in a playful way and encourage critical thinking when consuming information on social media

Background & Motivation

Smartphone, computer, Internet access and TV set – almost 100 % of all households in Germany are equipped with digital media devices. As a result, children and young people have daily contact with these devices. Media consumption is a natural part of their everyday lives as they discover their world with and through media.[1]

This discovery is overshadowed by false and misleading information which is becoming more prominent. In Germany, there are six interactions with fake news for every real news post on Facebook.[2] Many young people have limited knowledge about the functions and working methods of journalism.[3] School as an educational institution has the function of imparting to children a large part of the knowledge they need for life in society. According to the German government, this includes not only reading, writing and arithmetic, but also the new cultural technique of media literacy.[4]

Our timeline
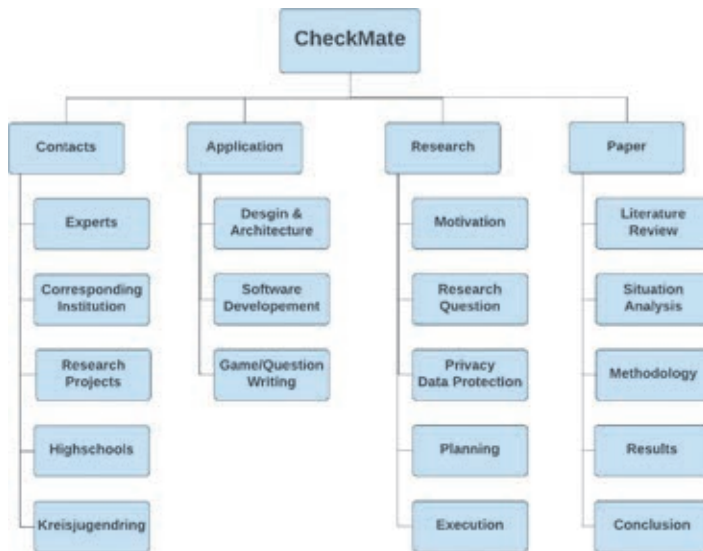
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Team
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Til Mathis Hagedorn
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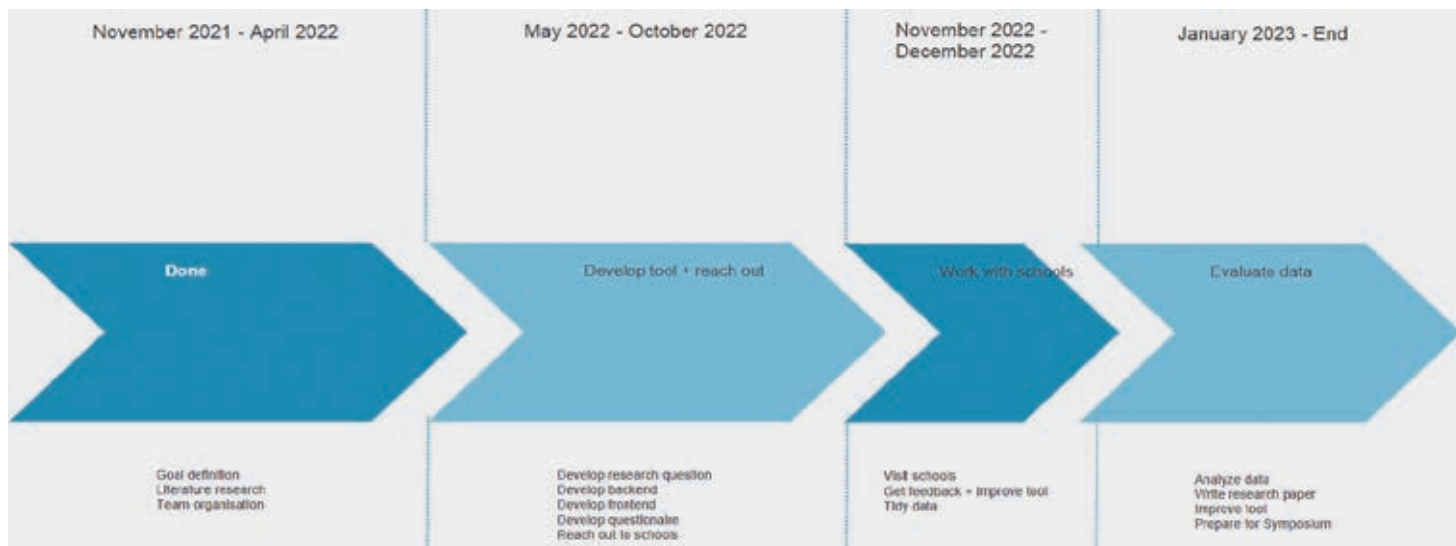Lucas Schnack
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Our project structure

Membrains

Team introduction

Our team Membrains is composed of seven team members. One Physics Bachelor student, two Mechanical Engineering Master students, two Engineering Science Bachelor students, one Medicine student and one TUM BWL Bachelor student. We are therefore a greatly interdisciplinary team and have come together to work on a project belonging to a field, where interdisciplinarity is a key ingredient: Biomimicry. Our goal is to get inspiration from nature in order to address a yet unsolved problem.

Problem to solve and Goals

For the last decades, the use of plastic in all sectors of activity has been responsible for a dramatic increase of microplastic in the environment. Not only does microplastic harm the fauna and the flora, it is also becoming an increasing problem in human health. Studies have shown that humans already have a non-negligible amount of microplastic in their bodies. An amount that adds up to a size comparable to that of a credit card.

We have therefore decided to try to improve microplastic filtration mechanisms in pipes, which could for example be used at the outlet of a washing machine to reduce the discharge of microplastic into our waste water and inevitability into the environment.

To reach this goal, we have turned to nature. From membranes to gills, filter mechanisms can be found everywhere in nature. Many animals and plants use them in order to protect or feed themselves. Marine animals using filter-feeder-mechanisms have proven to be particularly interesting in our quest. These animals get their food by filtering particles, which are in the same order of magnitude as microplastics. Two animals in particular have caught our attention: Manta Rays and Salps. Manta Ray can filter seawater without getting their gills clogged. This is possible due to the mechanical properties of the gills.Their anatomy creates a water swirl which makes particles bounce off. Salps on the other hand, can filter several liters of water per hour while measuring only around 10 centimeters. By controlling the water flow through their bodies, they can even filter particles smaller than the pores in their filters.

Our main goal is therefore to develop a real, working prototype and we think that Manta Rays and Salps can be the inspiration we need to create a novel non clogging filter. Our prototype should be able to make particles ricochet off itself and change the size of its pores. Furthermore, we want it to be able to filter microplastic ranging from 5 mm to 100 microns and to be compatible with pipes. In order to verify the need of such a filtration system our secondary goal will be to research the effects of microplastics on the human body and their abundance in food and the water supply.


Image 1: Photo of a Manta Ray (Wikipedia)

Image 2: Photo of Salps (The New York Times)

Methods

In order to reach our goal of a working prototype, we are first of all trying to gain as much knowledge as possible about filter feeder mechanisms, in particular about the feeding mechanisms of manta rays and salps. To do so, we are mainly relying on scientific articles and research as well as conducting interviews with experts in the domain. We have also been in contact with a team at the TUM, who had a similar idea of filtering microplastic by getting inspiration from mantas and who were able to create a first partly working prototype. When it comes to creating the prototype, we will perform simulations of water flow running through our prototype in order to get a better idea about how to improve the prototype's efficiency when it comes to filtration.
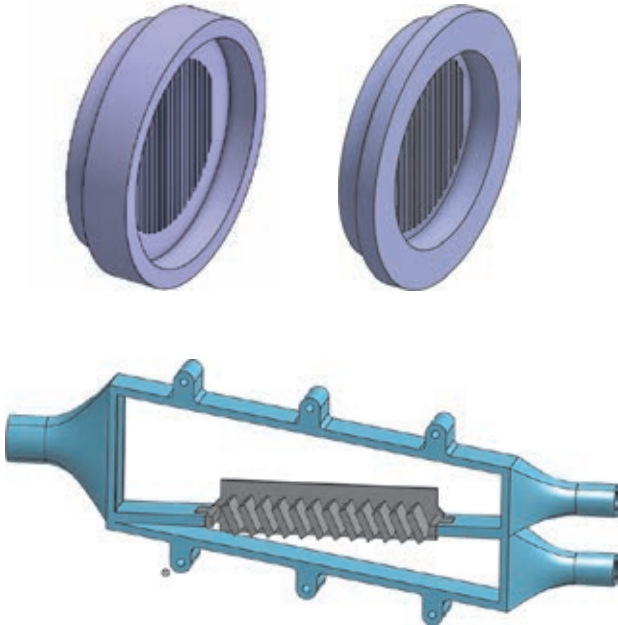
Images 3, 4, 5: Parts of our first prototype

This discovery is overshadowed by false and misleading information which is becoming more prominent. In Germany, there are six interactions with fake news for every real news post on Facebook.[2] Many young people have limited knowledge about the functions and working methods of journalism.[3] School as an educational institution has the function of imparting to children a large part of the knowledge they need for life in society. According to the German government, this includes not only reading, writing and arithmetic, but also the new cultural technique of media literacy.[4] ■

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SustainAct
Sustainability – Concept, Perception and Consumer Behavior

The Doughnut - a visual framework for sustainable development

Introduction

We are team SustainAct composed of seven students passionate about sustainability. Sustainability can be read and heard about almost everywhere – be it on social media, at the university or even in a grocery store. Traditionally, there are models of sustainability such as the three-pillar model (environmental, economic and social sustainability) or the doughnut model which are seen as role models for sustainable behavior. Our team aims to question the extent of application of these role models in our daily lives.

Hypothesis

In a simple scenario of buying groceries, does a consumer buy a product with her 'sustainability cap' on? How do people perceive sustainability and how do their 'sustainable' choices affect nature? Does one rely on ecolabels printed on the product or are there other factors such as price, taste, appearance that dominate one's choice? These issues can be summed up in terms of the following questions:
1. How do people perceive sustainability?
2. Do conceptual models work for everyone?
3. Is sustainability a purchase-decision criterion?
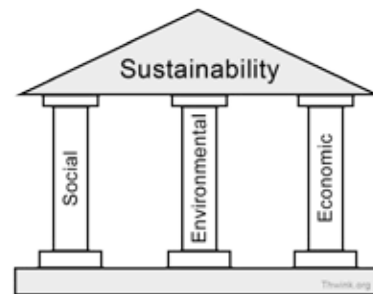
Three-pillar model of Sustainability

These questions are a stepping stone towards our main goal – can knowledge about sustainability alone influence one's behavior? The core problem of our project is to find out the uncertainties in people's perceptions of sustainability as a concept, and even in their understanding of the concept, if they implement it in their daily lives.

Methods

Our approach to the project will be to conduct surveys with 'choice' experiments. Three different experiment groups will be offered information about the concept of sustainability in different contexts – positive, negative and neutral. This information will be presented either in the form of a short video, or with the help of a website. The next step will be to observe if this information influences the participant's purchase choice – does she consciously look at the eco-labels printed on the product to make a choice or does she not consider the environmental effect the product has?

Given the information and data we collect from the said surveys, we shall be able to analyze the results and draw conclusions for the questions stated above. We intend to interact with different groups of people, to make our research as diverse as possible. ■

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VINFO

Our Team

Our team 'VINFO' (short for 'virulent information') focuses on the structure, spread and substance of SARS-CoV-2-related content on social media. Our point of interest is the German-speaking "Querdenker" movement, especially its online journalism. We aim to analyze Querdenker online articles empirically, quantitatively and qualitatevily. Doing so, we will utilize different approaches, notably quantitative content analysis as well as qualitative content analysis.

Background

Since about mid-2020, the main organizer of the protests against protective measures for the COVID-19 pandemic in Germany has been a semi-organized group called Querdenken (lit. 'lateral thinking'), which was initially based in Stuttgart but soon started to organize rallies and demonstrations also in other cities.

The group is a non-centralized movement consisting of individuals from varied backgrounds, including anti-government protesters, supporters of various conspiracy theories, anti-vaxxers and members of the far-right. Previous research has shown that different actors of the 'Querdenker' movement have different motivations in their political support and they are often united by anti-scientific content, published and distributed online. These Querdenker online articles are the subject of our research.

Research Objectives

COVID-related misinformation can be created or adapted from the truth to attract the attention of target groups. In our project we analyze the out-of-context usage of scientific information that leads to misinformaion in the Querdenker community. We would like to understand this COVID-related misinformation in more detail in terms of its structure and spread, and to do so we closely look at Querdenker online articles.

Our research questions are: To what extent is Covid-19 related information presented in a scientific manner in Querdenker online journalism? To what extent is this information aligned with information from scientific publications?

First, we examine the Querdenker online articles in terms of their emotional tone and in terms of their scientific terminology. To do this, we will use language analysis tools such as LIWC (Linguistic Inquiry and Word Count) and a self-created dictionary about scientific terminology based on various science journals. In a second step, we will qualitatively examine a certain number of Querdenker online articles as a sample. We try to trace back the sources of the articles, respectively trace them back to specific scientific publications. Later on we will focus on similarities and differences between the Querdenker online articles and the original scientific publication or in other words, investigate how they align with each other.

Expected Outcome and Implications
We expect to publish a scientific paper as the final product, which can serve as a reference for key stakeholders. Our goal is to raise awareness of the rapid dissemination of misinformation, to give recommendations and to understand the relation between misinformative content and science communication.

The beneficial implications of our research can be divided into two aspects. On one hand, research about the generation of misinformation from scientific events or facts can help practitioners– both in the fields of journalism and science – avoid communication strategies which allow subsequent weaponization and misinformation. As the relation between misinformation and science communication is not as well researched as its connection to mass media, our research would be highly beneficial for these communicators.

On the other hand, research on the 'Querdenker' movement is, due to its recency, not exhaustive and both scientific communities and the general public are lacking an understanding of the rapid polarization of our societies given the SARS-CoV-2 pandemic. In our work, we hope to provide a better understanding of the movement and to shed light on hard-to-uncover cycles of misinformation.

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Business Partner

The TUM: Junge Akademie cooperates with companies from economy and science. You, as a company, can benefit from the cooperation with the TUM: Junge Akademie and its excellent and highly motivated scholarship holders, who might even become part of your company one day. Are you interested? Then please contact our management or the Taskforce CAP (Contacts, Alliances, Partnerships).

Our partners have the opportunity
- to participate in selected events as well as the annual TUMJA Symposia
- to invite the scholarship holders to their company or institutions
- to assume mentoring for individual students or as part of projects
- to participate actively in expert discussions

Private individuals have the opportunity through a support partnership
- to participate in selected events as well as the annual conference
- to acquire personal sponsorships
- to supervise project groups
- to participate actively in expert discussions

Of course, you will be appreciated as a partner or as a private supporting member of the TUM: Junge Akademie. This includes in particular
- Your (company) name on the homepage of the TUM: Junge Akademie
- Your name on selected publications of the TUM: Junge Akademie as a supporting member

Scholarship Holder

The TUM: Junge Akademie scholarship program is open to all TUM students who are nominated by the Deans of Studies of their faculties or who submit an application including a recommendation by one of the professors of TUM. Students of HFF (Hochschule für Fernsehen und Film), ADBK (Akademie der Bildenden Künste), and HMTM (Hochschule für Musik und Theater München) are also invited to apply for the TUM: Junge Akademie. Apart from achievements during your studies, decisive criteria are creativity, community involvement, and willingness to take responsibility. Are you interested? Stay tuned for the next class of 2023 to apply in July 2022.

You are eligible if you are
- enrolled at TUM, ADBK, HFF, HMTM or LMU
- one of the outstanding students of your semester
- eager to develop yourself
- highly interested in science and research
- not compromised in your educational performance by the TUMJA membership

TUMJA scholarship holders at a workshop with our partner PIXIDA.