TUM: Junge Akademie

Research Reports 2023

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Partner of

TUM Universitätsstiftung

Freunde der TUM Association of Alumni and Friends

EuroTeQ Engineering University

Welcome to the *TUM: Junge Akademie*

What is TUM: Junge Akademie (TUM-JA)? Talented and ambitious students from different disciplines sort and structure ideas under an overarching theme, which is typically linked with a series of questions that navigate in open solution spaces, often even containing wicked problems. These ideas are turned into concrete projects starting from a hypothesis tested using scientific methods and discussed in relation to a concrete application or other tangible outcome. Apart from the project work, the students´ observations and self-reflections on what is related to inter- and transdisciplinary collaboration are crucial: What is sound research, what are the pitfalls of communication across disciplines, where are unconscious biases that limit cooperation, and how do we identify them? More than ever, such related skills and competencies are essential in order to understand social processes, implement innovations, and design sustainable value-creation processes- and, in short, to link the traditional learning categories of disciplinary facts, skills, and competencies with the attitudes, communication skills, empathy and ability for respectful co-creation needed to shape the future.

Since it was founded, TUMJA has provided us with a powerful field of experimentation. Traditionally, it is the partner we look to for ready solutions to problems outside our daily remit, ranging from helping refugees and testing new formats of intercultural communication to street science, to mention a few examples. Today, one remarkable example of the created impact is the challenge-based teaching format EuroTeQ Collider, which would certainly not have been so successful in shaping the EuroTeQ University Alliance if we had not gained valuable experience and insights into the opportunities and pitfalls of challenge-based learning by important pilots at our universities. The recent EuroTeQ Collider was again a great success, based on a call that sounds familiar: "Enhance connections for sustainable futures."

This booklet describes the work of the five student research groups that kicked off in November 2022 under the call *Less is more … Empowering individuals to focus on the essentials*. After clustering and brainstorming, five groups structured their projects into topics ranging from sleep-habits (*Somnoactive*), over adequate effective communication (*TUManywords*), holistically framed education (*ERIK*A*), supporting individual health (*Healthy Habits*), to the prediction of the impact of human activities and environmental phenomena (*TickTalkers*).

Today, twenty months after the start, all #class23 scholarship holders can rightly claim to have made substantial and successful progress. Even more so, since the Student Research Project is only one of the learning formats from which the scholarship holders, as well as the alumni, benefit. Commitment in one of the task forces, in which the scholarship holders shape and steer TUMJA on its responsibilities, is obligatory for all active participants. In addition, roles such as moderators, trainers, tutors, and mentors are options for all those involved as a further way to test and strengthen their skills.

Let me take this opportunity to thank all the stakeholders, students, dedicated mentors, tutors and sponsors, as well as our office, for making TUMJA such a great success. Be assured that your commitment lives on in the motivation and competencies of our scholarship-holders, who will have an impact on our societies in the upcoming years and decades.

I hope you enjoy reading this project book and wish you an exciting insight into the successful year of #class23.

Yours sincerely,

Gerhard Müller
Senior Vice President Academic and Student Affairs

Dear TUM friends and associates,

The TUM Junge Akademie (TUMJA) symbolizes academic excellence, showcasing the exceptional journey of talented and dedicated students within our dynamic TUM community. Since its inception, TUMJA has flourished into a remarkable success story, nurturing bright minds and fostering a culture of innovation and collaboration that enriches both individuals and the broader TUM ecosystem.

This year, TUMJA embarked on a mission under the theme "less is more," empowering individuals to focus on the essentials. This ethos reveals a tapestry of innovation, collaboration, and purpose, defining the spirit of the TUMJA community.

At the core of our mission is the commitment to nurturing and promoting young academics. This year's research report not only showcases scholarly pursuits but also celebrates TUMJA's role in cultivating the next generation of thought leaders. With a steadfast dedication to excellence and inclusivity, TUMJA serves as a beacon of opportunity, igniting passion and curiosity in aspiring scholars.

Interdisciplinarity is more than a buzzword; it is woven into TUM's fabric. Reflected in TUM's new school structure, interdisciplinary collaboration is the cornerstone of our approach. This cross-pollination of ideas distinguishes the student research teams within TUMJA, driving innovation across diverse fields.

The projects undertaken by this year's cohort exemplify our commitment to addressing real-world challenges. From Somnoactive's study of sleep improvement strategies to TUManywords' efforts to enhance accessibility for foreign students on TUM application websites, these projects embody ingenuity and empathy.

Projects like ERIK*A, Healthy Habits, and Tick Talkers delve into holistic sex education, promoting healthy habits, and leveraging data science for societal benefit, respectively. These initiatives showcase our dedication to addressing pressing issues and leveraging technology for the greater good.
As we embrace the ethos of "less is more," let us pursue clarity, purpose, and impact together. Let us transcend disciplinary boundaries, push the boundaries of knowledge, and empower individuals to shape a brighter, more sustainable future.

As President of TUM, I extend my heartfelt wishes to all TUMJA scholarship holders, alumni, friends, and sponsors. May your journey be fueled by curiosity and determination, and may success grace your endeavors abundantly.

Yours sincerely,

Thomas F. Hofmann
President

“Earth provides enough to satisfy every man's needs, but not every man's greed.”

Mahatma Gandhi (1869-1948)

TUM: Junge Akademie

TUM: Junge Akademie

Less is more

“Less is more. Empowering individuals to focus on the essentials.” This was the overarching call for #class23. “Less is more” must not be misunderstood to mean that we are retreating into the Stone Age by means of a general renunciation. Above all, “less” means questioning, “clearing out” the supposed “musts,” the things that are seen as “set” and carved in stone, and paradigms that have become superfluous. This must surely be accompanied, in a very specific manner, by a rethinking and an evolved, new idea of wealth, combined with new conceptualizations of how to ensure security, sustainability and the preservations of livelihoods. The call provided our student research teams with a starting point for five very different journeys into research and science. The results of these explorations are summarized in this book.

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 to 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.

TUMJA 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 through to concluding it as a final project report. Various workshops, such as for scientific and journalistic writing or project management, accompany the project work.

Commitment to the Program

In addition to project work, the TUMJA scholarship includes an extensive supporting program with community and network-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. ■

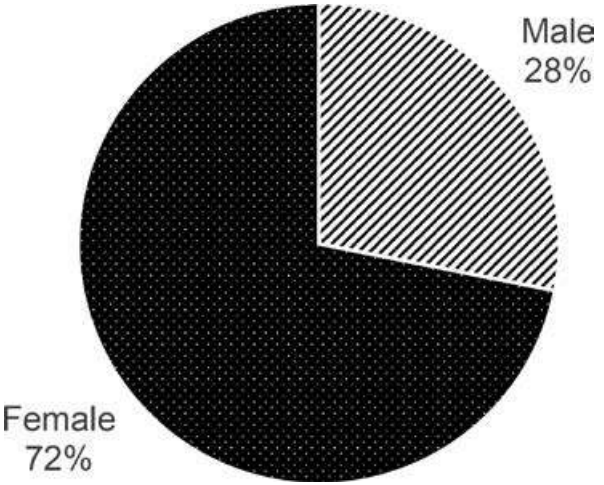
Facts and Figures

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

During the selection process for #class23, an average of 15 percent of all TUM students – the most outstanding in their fields – received a nomination to apply for a TUMJA scholarship. At three information events, around 450 interested students were able to get a detailed picture of what TUMJA has to offer. Eventually, TUMJA received 88 applications from nominated students. In a multi-stage application process, 64 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, 40 scholarship holders were accepted into #class23.

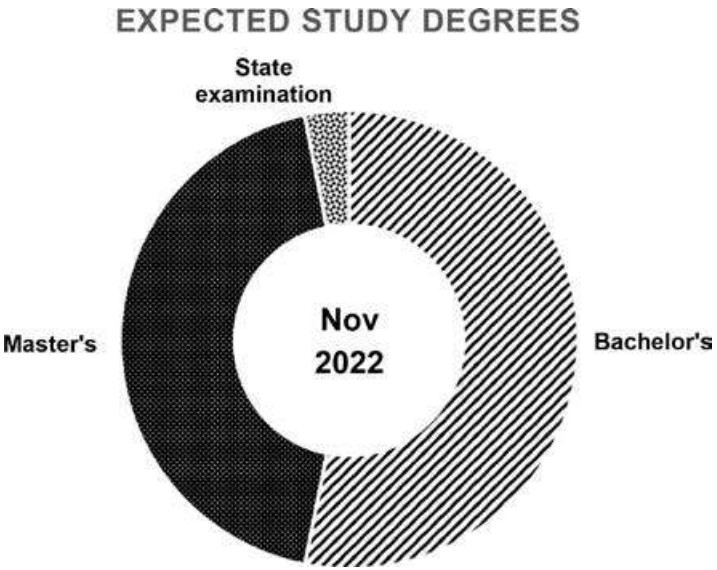
After 20 months of enriching and valuable experiences, 32 students successfully completed their TUMJA scholarships. See their portraits on pages 26-31.

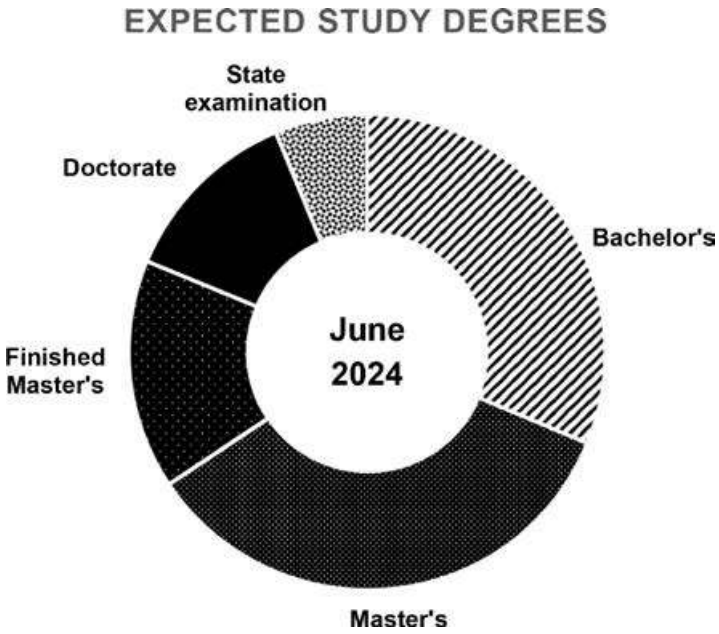
23 female and 9 male scholarship holders successfully completed their scholarships.

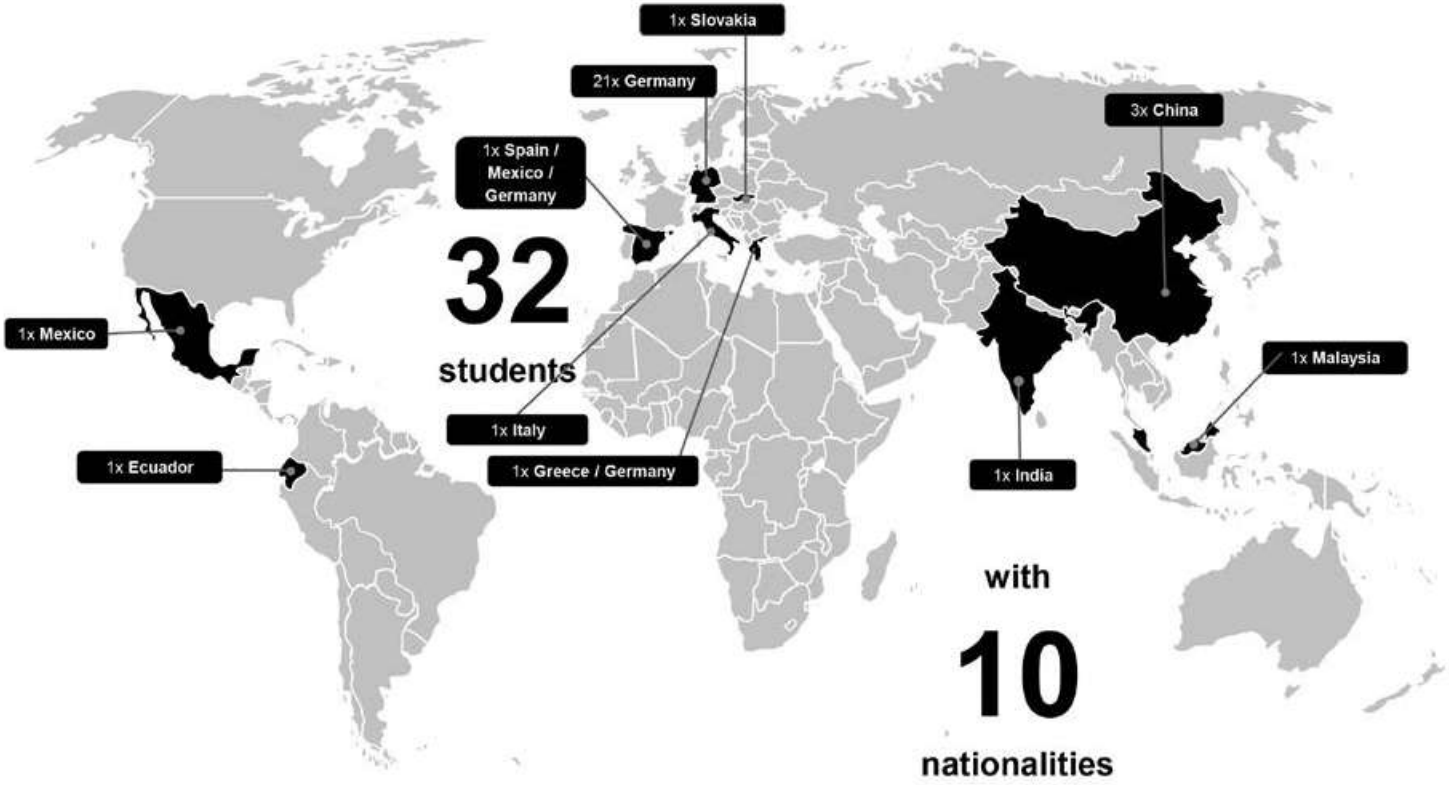


In addition to new subject-related insights, younger scholarship holders in particular benefit immensely from working with more experienced students who have already gained an insight into the world of science. This year, 14 Master's students and one student with state examination were happy to share their knowledge with 17 Bachelor's students.

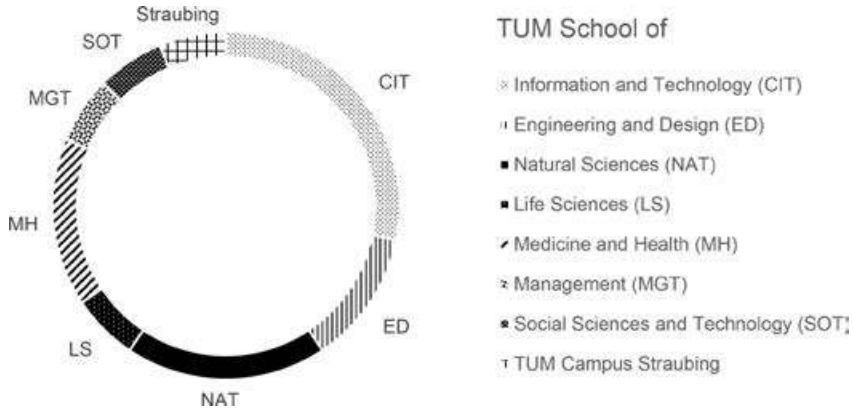
During the scholarship period, 7 scholarship holders finished their Bachelor's, from which 6 began a Master's and one a state examination program. 9 scholarship holders finished their Master's during the scholarship period. To our great delight, four of them started a doctorate.







The diversity of the scholarship holders is also apparent in their origins, as the chart above illustrates. The different international influences within the classes open up new perspectives and enrich the interdisciplinary cooperation with important intercultural aspects.



The innovative and creative ideas of the teams also grow through interdisciplinary interaction. This year's scholarship holders come from 21 different fields of study from all TUM schools. ■

Alumni interviews

Prof. Dr. Jana Ellegast
In an interview with Helene Jung
in December 2023

Short CV:

- Previous TUMJA program „Erfahrene Wege in die Forschung“
- Medical School, TUM
- Dissertation (Dr. med.) in Immunology, LMU
- Residency and Clinical Fellowship in Medical Oncology and Hematology
- Postdoctoral Researcher, Instructor, and Principal Investigator, Dana-Faber Cancer Institute, Harvard Medical School, Boston
- Assistant Professor for Translational Oncology, University of Zurich

Would you like to start by telling us what generally excites or inspires you?
Curiosity and a deep desire to understand biological processes in their greatest detail.

I have a long-standing passion for medically relevant basic science research. I am convinced that unraveling the fundamental principles of biology lays the groundwork for many medical breakthroughs; thus, studying the human immune system and the idea of leveraging this understanding for therapeutic strategies immediately excited me.

My aspiration to discover exceeds my professional life. I love sailing in uncharted terrains, backpacking, and mountaineering in regions I have never visited. I love to share discoveries with students and my family alike.

How did you decide to study medicine back then?
As a high school student, I thought there was nothing more fascinating than the

human body, so starting medical school seemed an obvious choice. From the beginning, I was determined to become a physician-scientist, as I felt immediately captivated by clinically relevant, basic biological questions from all possible exposures. As a medical student, I studied the differences between self and viral RNA in my doctoral thesis. I started thinking about ideas for bringing immunology to clinical translation in oncology. A sub-internship at the Memorial Sloan Kettering Cancer Center consolidated my fascination for cancer biology.

Taking care of patients and experiencing first-hand the clinical need for better cures has always inspired my work. Being trusted with the clinical care of patients is a great privilege; being able to contribute actively to improving outcomes and treatment options has also been an invaluable asset in my life as a physician-scientist.

I realize that this answer goes beyond your question ;-).

What is your favorite memory from your time in the "Erfahrene Wege in die Forschung" program?

The entire program was a pure delight. I was very fortunate to join the first cohort of this mentoring program, initiated by Professor Gerhard, an emeritus radiologist at "Klinikum Rechts der Isar." He was a role model as a physician, continued spreading the excitement and passion for his profession, and promoted a natural and healthy attitude to other essential aspects of life.

When I told him about my wish to enroll in an elective in radiology at UCSF, he connected me with the right person, and I had the privilege of spending an entire summer and fall in San Francisco. He always helped to build bridges and establish personal contacts.

I also remember presenting my experimental doctoral thesis to my co-mentees and mentors following his invitation, which exposed my work early on to a diverse audience.

Moreover, the program succeeded in an open-minded forum to learn about alternative career tracks and cultural diversity. After completing another elective at the Unidad Nacional de Oncologia Pediatrica, the largest pediatric oncology center in Guatemala, I shared some of my experiences in one of our meetings. Professor Gerhard must have felt my deep admiration for the mission and work of this pediatric oncology center and convinced me to present my impressions to a larger audience – which I finally did – combined with a call for donations supporting all the heroic and selfless workers and families who invested everything in getting treatment to as many children as possible.

One successful mentoring strategy was to build on an intrinsic interest and passion and offer support and encouragement to reduce obstacles or provide extra support. ■

Dr. Barbara Reiner
In an interview with Alexandra Marquardt and Steffen Wedig in May 2023

Short CV:

- TUMJA class 2013
- B.Sc and M.Sc in sport and health sciences
- Doctorate at “Deutsches Herzzentrum München”
- Postdoc at Chair of “Präventive Pädiatrie” / Employee at TUM Sport and Health for Life

What appeals to you about student health management and your current job?
The mix. It's excellent here, and every day is different for me. I do one or two days of diagnostics, including sports medicine and motor skills check-ups. However, what's crucial is our shift towards preventive measures. Even after the pilot phases in 2017 with smaller health-related tests and offers, but now increasingly in recent years, we keep seeing that it's not enough to diagnose, but that you have to do something preventively. Surveys have revealed alarming results, particularly in the area of mental health. We aim to improve the framework conditions at the university to establish a health-promoting lifestyle. The transition from adolescence to young adulthood is a fascinating phase because you can help shape so much.

You also dealt with mental health in TUM4Health. Is there anything that surprised you?
For one thing, I was amazed at how many students are open to this topic and how important it is for many to talk about it. Removing taboos from topics is a very inspiring step toward change. Many are open about their illnesses; they openly say that they feel overwhelmed, which was not possible in the past. Many seek advice and help. I believe the support programs are now much better received than they used to be. And there are a lot of students who come to us and say they would like to raise awareness. Mental health is an area that we are currently dealing with a lot. In 2022, we had an extensive survey in which five out of eight students stated that they often feel stressed. We had 32 percent who showed symptoms of anxiety disorders or depressive syndromes. You have to let these figures sink in. Around a third also say that they often feel exhausted. It is also an important issue for an excellent university: if I want to perform excellently, I need to be well-rested and be able to concentrate. But if these basic needs are not met, then performance will suffer. If I want to create excellent teaching and an excellent environment, health promotions, and healthy settings are part of this.

Which moments from your time at TUM-JA do you remember with particular fondness? Are there some key moments?
Yes, the annual campus run! The campus run was part of my project back then. In the beginning, we still timed the run by hand, and in the second year, we had just about 150 runners. This year [2023, editor's note], we had over 2,000 participants! The development is super nice, but every year also has its challenges. The night before and the day itself was very exciting every year. In the first year, we made a trailer to motivate the students, alumni, and staff to show that everyone has some motivation to run. We made a funny movie about the run to the subway. I think we filmed that moment 10,000 times when someone jumps against the closed door. That was a super funny shoot.

I also remember the opening weekend very well. We were in Berchtesgaden, and nobody knew what to expect. I think you know this phase, too: everyone has very different expectations, ideas, and characteristics, and it was exciting to grow together. ■

Prof. Dr. Cora Uhlemann
In an interview with Josephine van Delden
in August 2021

Short CV:

- Previous TUMJA program “Erfahrene Wege in die Forschung”
- Study of Physics and Mathematics at TUM
- Doctorate in Cosmology at LMU
- Assistant Professor at the University of Newcastle
- Professor of Cosmology at the University of Bielefeld

Was there a decisive moment when you realized you wanted to go into science and not business? Or was it a gradual process?
When I was in tenth grade at school, I had to give a presentation on fusion, and that's when I first thought: "Cool, maybe I'll become a plasma physicist." Then I studied physics, but I realized that plasma physics involves a lot of things I don't like, especially a lot of numerics. During my studies, I really enjoyed theoretical physics. When I started my PhD, I even hoped that the PhD would convince me that I didn't want to go into science. However, the PhD research was too much fun, and I wanted to keep climbing the career ladder in the ivory tower.

Can you give an insight into women in physics, in general, or in your field?
In theoretical physics, there are still very few female scientists – sometimes only 10%. In our department, however, we have made great strides forward. A few years ago, there was only one female colleague, but she campaigned hard to hire young people, which turned the tide a bit. Things are a bit better in astrophysics and astronomy, which adjoin my field. But even there, if you go to the level of permanent employees, it's only about 20% – so it's still much lower than you might hope.

Do you have any advice for us young students who are about to graduate?
The most empowering thing is to find out what truly appeals to you, and then, once you have decided, set clear boundaries and ask yourself, "What am I prepared to give for this?" Of course, this also depends a lot on your personal circumstances. So, identify what truly matters to you and set clear boundaries. For instance, I set a personal deadline: If I don't have a permanent job within eight years after my doctorate, I'll apply outside. So, set your boundaries, but if it's really what you want to do, go for it, even if the odds seem against you... and always have a plan B in mind. ■

Moritz Werb
In an interview with Samira Körner and Johann Ioannou-Nikolaides in Oktober 2023

Short CV:

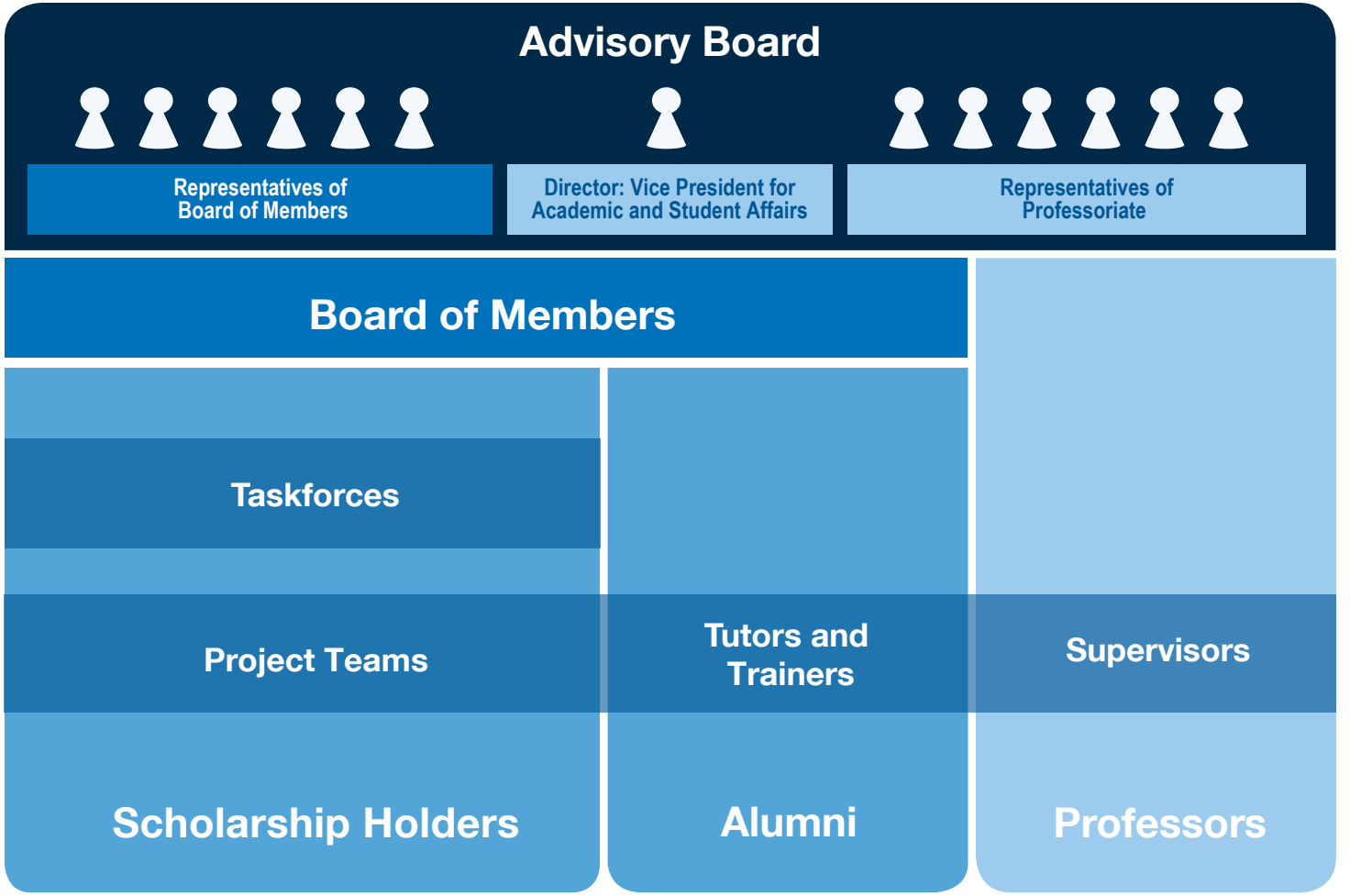
- TUMJA class 2013
- Study of mechanical engineering at TUM
- Senior Director Novo Nordisk

You specialized in medical technology during your studies and are now working in this sector. When did you realize that you wanted to go in this direction?
In hindsight, my choice of degree program may seem very deliberate, but it wasn't at all. After leaving school, I was torn between studying medicine and mechanical engineering. I did a gap year, where I traveled for six months and then did another six months of work experience. I also completed the nursing internship for medicine as well as the industrial internship for mechanical engineering. After that, I wanted to study medicine. But the numerus clausus changed because it was the year in which two years of students took their A-levels, and I didn't get a place to study medicine. As a result, I started studying mechanical engineering, and things went quite well during my studies. But this experience shaped me and led me to try to find a middle ground between medicine and mechanical engineering in my studies and career.

What are your fondest memories of TUMJA?
The thing I remember most is working across different areas of study. Such an experience is invaluable for your future career because you always come into contact with various areas of work and people. It's probably the case in every company that, at some point, you realize that you're no longer doing what you studied. And many people who work on the same project, for example, bring completely different experiences with them. In a TUMJA project – just like in real life – it's important to utilize each other's strengths and expertise without assuming that everyone brings the same elements to the table.

Your TUMJA project back in 2013 was called VisiTUM and focused on the transition from school to university. You aimed to counteract the trend of more students dropping out or changing their degree program. How did the project shape you? Did it make you approach the transition from university to working life differently?
It's exciting that you bring this up, as I have never considered it. I've been with the same company for seven years now, in different positions and countries. But it's still essential to me to give young people the opportunity to try out different professions. And that is, as you say, the same thing: To organize the transition between two stages of life as well as possible so that you know what you're getting into. ■

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 TUMJA. In November 2022 the new President of the University of Music and Performing Arts Munich, Prof. Lydia Grün, joined the Advisory Board. She succeeded Prof. Dr. Bernd Redmann, who had enriched the collaborative nature of the Advisory Board since 2016. Also since 2016, Prof. Bettina Reitz, President of the Munich University of Television and Film, has been a member of the Board. In 2023, Prof. Karen Pontoppidan, the President of the Munich Academy of Fine Arts, joined the Board.

A number of elected active and former scholarship holders of TUMJA 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 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 TUMJA 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 TUMJA. ■

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

Scholarship Representatives:
Monica Déchène
Dr. Matthias Lehner
Stefan Lehner
Magalie Ross
Paul Sieber
Martin Zirngibl

Professors:
Prof. Dr. med. Pascal Berberat,
TUM School of Medicine
Prof. Dr. Sonja Berensmeier,
TUM Department of Mechanical Engineering
Prof. Lydia Grün,
University of Music and Performing Arts Munich
Prof. Dr. med. (em.) Michael Molls,
Spokesperson Emeriti of Excellence
Prof. Karen Pontoppidan,
Academy of Fine Arts Munich
Prof. Bettina Reitz,
University of Television and Film Munich

Board of Members

The Board of Members (BoM) represents and stands up for all scholars' interests, develops ideas for the future of TUMJA and acts as an interface for other TUMJA departments/groups, e.g. taskforces, scholar teams, the office, trainers, supervisors and professors, among others. It is also for simply answering questions or streamlining them to the respective departments.

Everybody is invited to present their opinions/ideas at the BoM meetings. One thing we achieved in the first three months, for example, was to clean, re-structure and automate the BoM Wiki. This was in order to reduce administrative overheads and thus focus on the needs of scholars, but also, most importantly, to ensure that our deliberations and decision-making are transparent to those scholars, for whom we are responsible and for whom the BoM primarily exists.

In the periodic meetings, the project groups and taskforces provide updates about the current state of their research project or tasks, and share ideas or advice to support one another. In addition to the representatives of each group, all active members and alumni are invited to join the meetings and contribute their experiences and suggestions. But the BoM meetings are not only for helping each other: They are also to represent the wishes and needs of scholars to the TUMJA Office and thus shape the future of TUMJA. With all opinions taken into account, the BoM consists of a strong community for the interests of TUMJA scholars.

To have the voices of the scholars also in the Advisory Board, the BoM sends six student representatives to the Advisory Board. This guarantees a versatile and rich participation in middle- and long-term decisions for TUMJA. ■

ja.tum.de/wir/board-of-members

From left: Nicolas Ian Lugger, Liza Saneblidze and Maximilian Josef Frank

TUMJA Office

The TUMJA office staff assists its scholarship holders in planning, organizing, implementing, and evaluating their projects and ideas. This support can be diverse. Where one team needs technological support, another team might need the right people to get in touch with. The office pays special attention to networking and joint cooperation between all members. Together with Taskforce Event, unforgettable experiences are created, such as visits to museums, running dinners or Christmas parties. The teams are free to use the TUMJA premises, especially to hold team or taskforce meetings. The premises also invite you to spend some time together once the meetings are over.

The TUMJA management, however, does not only take care of the concerns of the scholarship holders. It also serves as a point of contact for connecting with other TUM internal or external partners. The office team is always in close contact with its partners, such as the TUM Universitätsstiftung, the industrial partners Pixida and QuantCo, and the partner universities in Munich.

Some of the core tasks primarily include administrative and financial matters. The planning, coordination, and realization of seminar weekends and workshops also fall within the broad range of tasks. In addition, TUMJA hosts several extraordinary events, such as academy talks, fireside chats in cooperation with TUM Graduate School, the TUM Science Hackathon, and the annual TUM campus run. Since 2023, TUMJA has been actively involved in the EuroTeQ Collider and organized its first Collider project weeks in 2024.

We would like briefly to introduce the people who stand behind the organization of these tasks, as follows:

- The director of TUMJA and head of the TUMJA advisory board is Professor Gerhard Müller.
- The Managing Director, Peter Finger, has continuously provided new ideas and improvements for TUMJA since 2012.
- Angela Wester joined the team in April 2024 as EuroTeQ Collider Manager.
- Dennis Lehmann is responsible for administration and other general matters.
- The field of public relations falls within Constanze Kukula's responsibilities.
- In addition, student assistants Eya Ghanmi, Rosyida Hasna Kumala Dewi, Xinya Tang, Anna Forster, and Max Atta actively support the office during the year. ■

Faces

Scholarship Holders 2023

Raluca Ana Maria **Barna**

Healthy Habits
Biomedical Engineering and Medical Physics

TUMJA taught me how to manage a team and to deal with meeting tasks and responsibilities. It's a unique experience that can give a glimpse of the working dynamics the students will face further in their careers.

Florian **Brandl**

Somnoactive
Data Engineering & Analytics

My most exciting contacts are definitely the members of my team, as we have gotten quite close during the scholarship. I'm very happy to have such a close connection to so many talented and remarkable people.

Sophie **Ebert**
ERIK*A
Conservation an
Landscape Planning

My motivation for research is the opportunity to play an active role in shaping society and the future.

Franka Elektra **Exner**
Tick Talkers
Mathematics

One particularly valuable aspect of my time at TUMJA was the relationships that developed within the team.

Moritz **Friedemann**
Healthy Habits
Informatics

The scholarship offered me many perspectives from outside my discipline and motivates me to start new projects soon. It also let me meet many wonderful people.

Daniel **Gögelein**
ERIK*A
RESET

Science and research will forever and always be the way to gain knowledge, and the laws of science will bring us forward. I want to be part of that.

Claudia
Guadarrama Serrano
Tick Talkers
Chemical Biotechnology

I have always been a curious person who asks a lot of questions and likes to create new things. I believe that through science/research, you can create new things that improve people's lives.

Vedant **Gupta**
Somnoactive
Aerospace

I really enjoyed the trip to Schliersbergalm! Brainstorming ideas for a very crucial decision for our group while staying in a lovely lodge in the snowy weather was really a wonderful memory!

Sandra **Gross**
Healthy Habits
Data Science

In TUMJA, the diversity of this scholarship definitely makes the difference: The collaboration among scholars from diverse backgrounds results in innovative solutions and holistic research outcomes.

Veronika **Hofmann**
TUManywords
Mathematics

The moments that I loved the most were the ones that showed me how I can really rely on my team!

Samira **Körner**
Somnoactive
Life Science Biology

The most exciting contact was with Prof. Adebanji, our hosting Professor at KNUST. She was a big inspiration for me.

Johanna **Lebmeier**
ERIK*A
Health Science

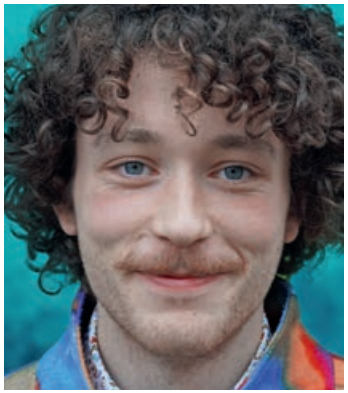
There's no single defining "best" moment but rather the collective energy and joy we experienced as a class.

Xufan **Lu**
Tick Talkers
Information Systems

I loved the moments we got together as a team, brainstormed new ideas, and worked on them together.

Alexandra Cara **Marquardt**
Healthy Habits
Informatics

The seminar weekends were all my highlights, but especially the one on the Schliersbergalm with its unique and idyllic location on the mountain.



Johann **Ioannou-Nikolaides**
Somnoactive
Nuclear, Particle and Astrophysics

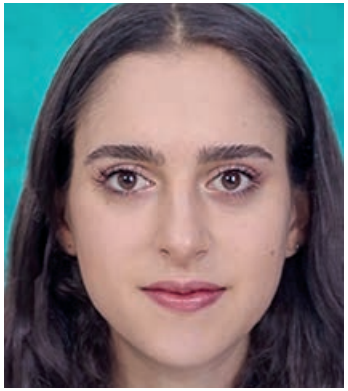
My best moment at TUMJA: Playing football with the kids at a remote school in Northern Ghana, realizing how far our project had brought us.

Helene **Jung**
Healthy Habits
Health Science

The most exciting contacts I've made at TUMJA were definitely my teammates and tutors, who inspired me to work hard and sparked my interest in new fields of science.

Camila **Loaiza Santos**
Healthy Habits
Sustainable Management and Technology

The time I spent at TUMJA has been an amazing journey of learning, thanks to the support and unique skills of my team!!



Rui Yee **Loke**
ERIK*A
PhD in Physics of Synthetic Biological Systems

My motivation for science is to continuously learn new knowledge and acquire new skills.

Vivian **Meier**
Somnoactive
Chemistry

My motivation for science is primarily driven by curiosity and the opportunity to contribute in a small way to solving complex problems our society is currently facing.

Luisa Franziska **Metten**
Somnoactive
Aerospace

TUMJA has taught me a lot. Not only about Research and Teamwork, but also about my own strengths and aspirations. All of these aspects will definitely be a benefit down the line.

Carolin **Niedermaier**
Tick Talkers
Human medicine

In this ever-changing world, I want to make my contribution to research and science. TUMJA allowed me to get to know other subjects besides medicine and to do interdisciplinary research.

Euridice
Pinheiro Vieira Harke
TUManywords
Industrial Biotechnology

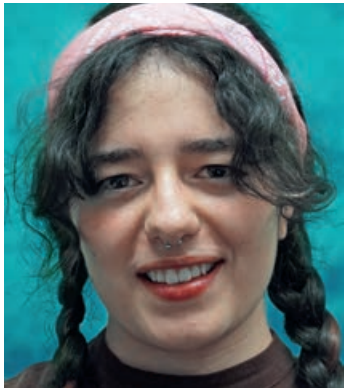
The best moment at TUMJA was visiting São Paulo with my project team. On my own, I would never have had the courage to visit Brazil and never have seen a very unexpected part of the country.

Magalie **Roß**
Healthy Habits
Management and Technology

In my study program, there is little space for doing research. Yet, I love to deep dive into some topics without the pressure of getting a grade on it. TUMJA gave me the room and knowledge to do this.

Tina **Schiele**
ERIK*A
Educational Science/
Psychology

My motivation for science and research: Communicating scientific findings to the public in order to help improve everyday life.



Ines **Velasco Martinez**
TUManywords
Aerospace

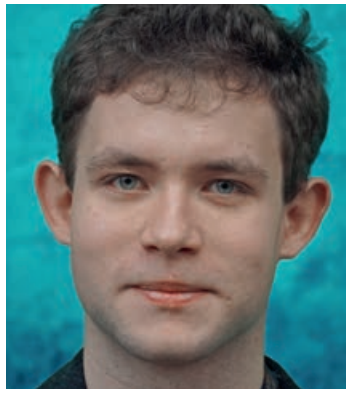
One of our most memorable meetings was with the students from Tsinghua University. It was great interchanging cultures and learning about academic life and research objectives across the world.

Ziwei **Wang**
TUManywords
Biochemistry

The most valuable part of our project and TUMJA is having such a fantastic team and getting close to these inspiring people. Our time in Sao Paulo was and will also be one of the most memorable experiences I have ever had.

Flavio **Principato**
Healthy Habits
Mathematics

After the #class22 symposium, the atmosphere was filled with such positive energy - everything went as planned, the guests enjoyed it. This was a prime example of how amazing the TUMJA community is.



Peter **Ridilla**
TUManywords
Informatics

My best moment at TUMJA was definitely the trip to Brazil. I could experience a new country and culture I wouldn't be able to see otherwise.

David **Schuster**
Somnoactive
Elektro- und Informationstechnik

My most exciting contacts? Actually the whole network. Starting from people in the office over to my fellow team members and all the extras the scholaship brought like speaking coaching with Jörg.

Lena Maria **Straßer**
Somnoactive
Sports Science

It was a great experience to work on our project together as a group of students from very different fields of study and to combine our interdisciplinary backgrounds to reach a common goal.

Letizia **Wörrlein**
Tick Talkers
Health Science - Prevention and Health Promotion

I liked walking down the hills of Kloster Andechs at night. I also appreciated meeting experts like Thomas Fromm, recruiting new scholarship holders and foremost the dedicated support from TUMJA.

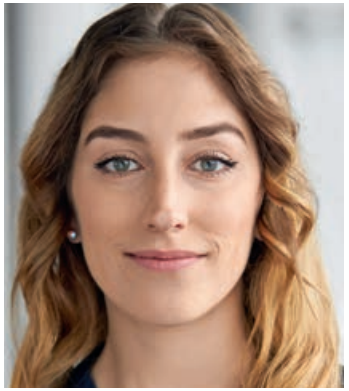
Shaoming **Zhang**
Tick Talkers
Physics

TUMJA's invaluable for my studies; it enriches technical and interdisciplinary skills, fostering strategic research and problem-solving.

Tutors

Monica **Déchène**
ERIK*A
LMU IfKW & TUM School of Social Sciences and Technology

I thoroughly enjoyed supporting ERIK*A, who showed great enthusiasm for research and also courageously delved into the intricate topic of sex education in Bavaria, conducting comprehensive analyses.



Leonardo **Gianotti**
Tick Talkers
Statistics & Data Science
@ LMU

Working as a tutor taught me that Communication is key.

Bernard **Häfner**
TUManywords
BMW Group

It's rewarding to be able to give back some experiences and perspectives, and also to see the team grow (together and individually) and accomplish something within the time frame of the program.

Daniel **Khadra**
Tick Talkers
TUM School of Computation, Information and Technology

My best moment at TUMJA: Meeting incredible people who became close friends.

Jan **Kochanowski**
Healthy Habits
Institute Polytechnique de Paris

Being a tutor gave me an insightful change of perspective into a more supervising role, in contrast to my usual day to day as a PhD student. And also a fascinating insight into social and humanitarian sciences.

Nico **Michel**
ERIK*A
Mechanical Engineering,
TUM School of Engineering and Design

TUMJA is a special place where people from different backgrounds come together, which creates an extremely creative environment that enables out-of-the-box thinking and leads to unique outcomes.

Genoveva **Müller**
Somnoactive
TUM School of Medicine & Health

Being a tutor offers the valuable opportunity to deepen your own knowledge of teamwork and new topics, collaborate with interesting people, and experience the success of the team in achieving its goals.

Elisa **Rodepeter**
Somnoactive
Phd @ ZEW / Leibniz Centre for European Economic Research

Being part of TUMJA is a unique opportunity to learn, as a student and as a mentor. Watching ideas grow into successful (research) projects is so rewarding, and I am truly impressed by the students of this program, congratulations!

Leonard **Schmitt**
Healthy Habits
TUM School of Medicine and Health

Working as a tutor taught me a lot about team dynamics and helped me to learn how to neither over- nor undermanage.

Sebastian **Zäpfel**
TUManywords
Alumnus TUM School of Management

Programs like TUMJA create a win-win situation for both, the mentees and mentors – if they engage actively and are open for personal growth.

Supervisors

Prof. Niklas **Fanelsa**
Tick Talkers
TUM School of Engineering and Design

For me, mentoring means sharing knowledge at eye level while being open and curious.

Prof. Dr. Doris **Holzberger**
ERIK*A
TUM School of Social Sciences and Technology

I particularly enjoyed working with this highly engaged, motivated, and interdisciplinary group, as it allowed me to foster their understanding of empirical research.

Prof. Dr. Enkelejda **Kasneci**
Tick Talkers
TUM School of Social Sciences and Technology

I am delighted to see the team's development through the TUMJA program in conducting research, working collaboratively, and managing tasks.

Prof. Dr. Claudia **Klüppelberg**
TUManywords
TUM School of Natural Sciences

Interdisciplinary is the future, and TUMJA lives it.

Prof. Dr.
Volker **Nürnberg**

Healthy Habits
Allensbach Hochschule / Management im Gesundheitswesen

My motivation for science and research: I would like to improve health promotion in all settings (at work, university, neighborhood, etc.) with innovations.

Prof. Dr. Philipp **Reiss**

Somnoactive
TUM School of Engineering and Design

It was an insightful experience to see how the team developed their idea and realized it within a very short time besides their studies.

Prof. Dr.
Florian **Röhrbein**

Healthy Habits
TU Chemnitz / Neurobiotics

I very much enjoyed being once more part of TUMJA. I wish everyone in my team a lot of healthy habits!

Prof. Dr. Sylvia **Rothe**

TUManywords
HFF / AI in Media Production

TUMJA is a great opportunity for students interested in research to get in touch with each other, gain experience, and work on great projects.

Prof. Dr.
Manuel **Spitschan**

Somnoactive
TUM School of Medicine and Health

It was great to see the team flourish and take full ownership of the project.

Yao **Rong**

Tick Talkers
TUM School of Social Sciences and Technology

Mentoring the TUMJA project, I witnessed the vitality of emerging researchers, and I am glad that we are growing together.

Projects 2023

Research Report **ERIK*A**

Sex education can lead to a healthy and respectful understanding of sexuality and thus make an important contribution to individual and societal development. However, sex education in Bavarian schools rarely meets these requirements. Team ERIK*A attempted to give a status report of current sex education at Bavarian schools and to find out how holistic sex education should actually be designed to meet the demands of experts, teachers and students.

Team	Tina Schiele Johanna Lebmeier Rui Yee Loke Sophie Ebert Daniel Gögelein
Tutors	Monica Déchène Nico Michel
Supervisor	Prof. Dr. Doris Holzberger

Preface by the Supervisor

Prof. Dr. Doris Holzberger

Let's talk about sex! But how? Sex Education (SexEd) touches many important societal topics, such as health, the prevention of violence, equality and diversity. The ERIK*A project put Bavarian Sex Education to the test and entered a research field which has been underexplored, so far.

Sex Education is an integral part of general education in Bavaria. But does it meet the requirements of today's students? Do Bavarian schools provide young people with the necessary holistic approach regarding sex and all its related aspects? Looking at SexEd in Bavaria the ERIK*A Team discovered a more conservative approach than recommended in other German guidelines, particularly concerning gender identity and non-heteronormative lifestyles. Though Bavaria's official guidelines do advocate comprehensive, interdisciplinary SexEd – including biological aspects, gender roles and identity as well as communication and social circumstances – this is not adequately reflected in actual teaching practice. In addition, SexEd classes seem to rely a lot on the individual teachers as they select content according to their personal interests and knowledge rather than being specifically trained in SexEd. But what are the reasons for this disparity?

The ERIK*A project identified several factors which are crucial for a holistic SexEd in Bavaria that meets the needs of young people. They demonstrate that time, safe spaces, teacher expertise and the curriculum itself are important elements for the success of SexEd within schools. However, that external conditions also come into play, such as parents, non-school educational influences, or societal taboos.

As SexEd covers more than just biology, ERIK*A shows how including relationships, gender identities, and emotions is crucial to providing young people with support, especially if students lack it at home. They also spotlight the fact that sexuality remains a societal taboo even in our modern society, causing insecurity and ignorance, particularly among girls, and complicating its discussion in schools. The students of the ERIK*A project hence call for a diverse and open approach to SexEd that respects varied human identities. To achieve effective SexEd they suggest providing more resources and suitable learning environments, and improving teacher training. ERIK*A's approach relies on the participation of students in the curriculum through their questions and interests, and suggests that creating an open, question-friendly atmosphere is important. Their goal is to foster sexually self-determined individuals who respect boundaries.

The students from ERIK*A were highly motivated and offer a new perspective on the topic of SexEd which is very important as children are increasingly confronted with sexualized topics at a younger age via social media. I was happy to support the project.

Supervisor Insights

What is your research interest or motivation for science?
I've always been drawn to science because it creates knowledge that can be practically applied. It has been important to me not to be a researcher apart from practical implications, but to engage with individuals in educational practice. I want to contribute to bringing innovative educational concepts to German schools.

What was your best TUMJA moment?
My best TUMJA moment was when we sat together as a team and collaboratively discussed the project's goals and all the elements involved. The ERIK*A members were very motivated and full of exciting ideas. Each member contributed their insights and perspectives. It was inspiring to see a well-developed plan evolve.

How did your work as a supervisor influence you individually?
I particularly enjoyed working with this highly engaged, motivated, and interdisciplinary group, as it allowed me to foster their understanding of empirical research. It was incredibly rewarding to see their growth and enthusiasm as they delved into complex topics. Additionally, I found it exciting to adapt specific methodologies to a research area that is related to, but not the core of, my current research. This process not only broadened my own expertise but also brought fresh perspectives to the project, making the work both challenging and enjoyable.

The age of Enlightenment?

A plea for holistic sex education in Bavarian schools

"Hush, please!," calls out the teacher at a commercial college in Munich. It's Wednesday afternoon, two days before the start of the Pentecost holidays, and not only is the room temperature running high, but so are the emotions. From everywhere, we hear giggles and whispers. A variety of emotions are reflected on faces: amusement, curiosity, discomfort, shame. The teacher tries more energetically to make herself heard and to bring the excited atmosphere in the classroom under control. She looks exhausted. In her hand, she holds a wooden penis, with which she now taps irritably on the table. "Quiet!"

In the double period of "People and the Environment," the 8th-grade students today have "Sex Education" instead of physics, chemistry, or biology. Originally, there were supposed to be two topics: STDs, which stands for sexually transmitted diseases, and contraception. It's a tight schedule, but more time is not allocated for sex education topics in the final year at this school. The excitement in the class stems from a student's question about abortion, but the teacher doesn't want to discuss it today. Instead, they continue with the application of condoms.

After the lesson, she tells us she doesn't have the necessary personal distance from the topic of abortion. "For me, it's an ethical-moral question and therefore an opinion. And my opinion is not wanted in class. I think the curriculum even prohibits that for us teachers. I wouldn't be objective on the topic of abortion. I simply don't know enough about it, and, in the end, I might even breach the legal framework."

"In class, my opinion is not wanted. I believe the curriculum prohibits that for us teachers."

Considering the extensive curriculum for sex education in Bavarian schools, this teacher's uncertainties seem not to be isolated, as a study by interdisciplinary scientists from the Technical University of Munich now shows. Through in-depth analysis and interviews with students, teachers, scientists, therapists, and ministry officials, the "ERIK*A Study" identified significant obstacles in the theory-practice transfer. According to the curriculum, students from the first to the final grade should learn about their relationship with themselves, others, and society, about their bodies and health, media and pornography, consent, and cis- and heteronormativity. But also, law and religion are on the agenda in the "Guidelines for Family and Sexual Education in Bavarian Schools" issued by the Bavarian State Ministry of Education and Culture, Science, and the Arts. In terms of content, the diverse topics of the curriculum in this field, for which early and comprehensive education is also advocated by the WHO, could probably fill an entire school subject program on their own. However, "Sex Education" is mostly located within the natural sciences subjects, such as biology classes, or subjects like nature and technology. The planning of the teaching units and the timeframe are the responsibility of individual schools and subject teachers. The practical implementation of the guidelines is thus automatically limited since teachers usually rely on their interests and abilities when selecting content and teaching methods instead of relying on thorough training and further education. And even if educational professionals attach great importance to sexual education,

implementation fails due to time constraints, as not everything can be adequately addressed. This gap between theory and practice means that despite positive developments, school-based sex education still does not meet the needs of students. The result: young adults who are not adequately, or not at all, informed about sexuality — a situation that can have far-reaching consequences, as a sex therapist is quoted as saying in the study: "A major issue is sexuality itself. Who am I, what do I like, what do I need, where are my boundaries? How do I talk about it with a partner, with friends? Because sexuality is still a highly tabooed topic, it's not socially acceptable. One's own body, sexual desires, orgasms are sometimes even associated with shame. Unfortunately, many young people come to my practice who have experienced negative things and sexualized violence and who have not dared to talk about it. Only when pathologies appear, especially depression, do some, and certainly not all, find their way to our practices."

"Who am I, what do I like, what do I need, where are my boundaries? Sexuality is still a highly tabooed topic, it's not socially acceptable. One's own body, sexual desires, orgasms are sometimes even associated with shame."

Comprehensive and early education could provide a remedy by destigmatizing, empowering, and encouraging, says the expert. The curriculum provides a good theoretical foundation for this, but practice shows that the curriculum is more of an ideal, the implementation of which has not worked so far. To overcome this gap, the study proposes a concrete solution: the successful practical implementation of the curriculum in Bavarian schools depends to a large extent on the availability of two resources. On the one hand, it requires trained and sensitized staff, and on the other hand, it requires significantly more time to address the diverse and demanding topics of the curriculum. Also, it requires the ability of teachers to create a suitable learning environment, a safe space for both sides where topics can be discussed with the necessary seriousness and without shame. The applied teaching itself should then be continuously evaluated and adapted to the needs and interests of the students so that the school becomes the urgently needed point of contact for children and adolescents, especially if the parental home does not provide sufficient support.

The students of the 8th grade of the Munich commercial college can confirm this research result. "I don't want to feel intimidated or uncertain about asking a question without being looked at strangely or laughed at. And I wish the teacher simply knew what she's talking about so she can convey the information well." At the end of the fourth hour, we leave a classroom full of exhausted people, with dissatisfaction on both sides. Sex education in Bavarian schools fails to live up to the good intentions of the curriculum. In order to meet the high demands of the curriculum and also the societal responsibility that the school carries as a public institution, the lived practice of sexual education must be fundamentally rethought. A massive step that can hopefully be set in motion now through the insights of the "ERIK*A Study."

Research Report – ERIK*A

Qualitative Analysis of Success Conditions and Hurdles in Bavarian Sex Education

Table of contents:

Abstract

Building lasting habits takes on average 66 days until they become iHolistic sex education (SexEd) plays a crucial role in addressing the physical, emotional, and interpersonal dimensions of sexuality and relationships. While the World Health Organization (WHO) advocates for early, comprehensive SexEd, it often falls short in meeting the legitimate demands of children and adolescents amidst their personal growth, particularly within the predominantly conservative approach adopted by the Bavarian education system.

This report presents a comprehensive investigation into the theory-practice transfer of SexEd in Bavarian schools, exploring the conditions driving success and the hurdles in implementing guidelines from the Ministry of Education into teaching practice in schools.

Adopting the reflexive grounded theory methodology, guided interviews with diverse stakeholders were conducted to gather different perspectives on the topic based on personal experiences. Collected observations and dialogues were evaluated and systematically categorized according to their content and relationships. Interactive workshops conducted with associated students served as field observations as a way of understanding their viewpoints on current SexEd provision. Axial, selective, and iterative coding of all collected data governed the categorization of key themes addressing success and hurdles in current practices. Methodological reflexivity was maintained throughout the research process to acknowledge and mitigate researcher biases.

Findings reveal both opportunities and risks for meaningful SexEd theory-practice transfer, encompassing various dimensions. Despite limitations in data comprehensiveness due to practical constraints, the study provides valuable insights into the multifaceted landscape of SexEd in Bavarian schools. There is a consensus among experts on the importance of holistic SexEd that reflects contemporary issues and responds to changing social values, highlighting the implication that diversity, openness, and attentiveness are crucial in SexEd delivery.

1. Background

1.1 Holistic Sex Education and the Importance of its Implementation in Schools

The profound social changes of the 21st century, characterized by shifts in cultural norms and evolving attitudes toward diversity and gender equality, highlight the increasing demand for holistic sex education (SexEd) as an integral aspect of personal and social development.

SexEd can be understood as "the self-development of a person's sexual identity that goes beyond preventive competences and is supported by learning-promoting impulses with the aim of their individually satisfying and socially acceptable development at all levels of personality and at all ages" (Sielert, 2015, p. 12).

The World Health Organization's Regional Office for Europe (WHO), in collaboration with the German Federal Centre for Health Education (Bundeszentrale für gesundheitliche Aufklärung, BZgA), advocates for early, holistic SexEd from birth (WHO & BZgA, 2011). According to them, holistic SexEd "encompasses not only physical, emotional, and interpersonal aspects of sexuality and sexual contact, but also a range of other aspects such as friendship or feelings of safety, security, and attraction" (p. 13). Holistic SexEd thus transcends biological, anatomical, and disease-related aspects, challenging socially widespread notions of fertilization and sexually transmitted infections (STIs) as the sole foundations of sexuality. Definitions of BZgA and WHO underline the importance of sexuality for personal identity and its significant interpersonal dimension.

The need for early and holistic SexEd is reflected in the development and interests of children and adolescents. At the age of two to three, children already recognize socially ascribed physical and behavioral differences between men and women while they begin to discover their own bodies at the same time (Berenbaum et al., 2008). Upon entering school, the WHO & BZgA (2011) assumed that children realize the prevalent taboo surrounding sexuality and associated body parts yet lack the knowledge to classify it appropriately. As they transition to secondary school, the onset of puberty emerges as a significant focus, initiating the development and consolidation of the children's identities (Habermas & de Silveira, 2008; McEwen, 2003). The perception of one's own body and its boundaries as well as those of others, along with the processing of emotions are crucial aspects for children long before their first actual sexual experiences (WHO & BZgA, 2011). Hence, early SexEd is essential so that they are not left alone to deal with the development of these aspects.

Similar to their physical development, the interests of children and adolescents evolve in relation to their SexEd. While 13-year-olds remain eager to learn about changes during puberty, older adolescents from the age of 15 are more interested in STIs and contraception (Gilbert et al., 2005). At the same time, topics such as sexual identity and orientation as well as answers about relationships or prevention prove to be consistently interesting, regardless of the age of the adolescents (McCarthy et al., 2012).

Children and adolescents seek answers to their questions from various sources. In addition to peers, parents, siblings and school, the media play a particularly important role in this regard. In their review, Simon and Daneback (2013) report that up to 77 % of the surveyed adolescents use the internet to inquire about SexEd-related topics. With the emergence of new social media platforms such as TikTok, this percentage is expected to have risen since 2013. Particularly for adolescents from families that strongly taboo sexuality and queer young individuals, online searches provide a safe space where they can find answers to questions they are unable to ask their parents or teachers (DeHaan et al., 2012; Holstrom, 2015).

However, the quality of information available on the internet is mixed. Many sites reproduce myths and sexist or discriminatory prejudices, or simply provide false information (Buhi, 2010; Döring, 2015; Yen, 2010). As educational institutions, schools therefore play an important role in providing a holistic SexEd to counteract this misinformation and serve as a trusted source of accurate information and scientific knowledge.

1.2 SexEd in Germany

In Germany, SexEd is mandated by legislation and is considered an integral part of general education. While in the 1970s SexEd was still seen as a transfer of knowledge, the depth and communication of which could be hindered to some extent by parents, in the 1990s it was stipulated by law that SexEd must go beyond the transfer of knowledge of physical and biological processes and cover social and emotional areas (Sielert, 2011). At present, SexEd is integrated into general education through the enforcement of BZgA, in cooperation with the authorities of the federal states, supported by German family counselling institutions (e.g., pro familia) and non-governmental organizations (NGOs). The development of curricula is guided by the Standards for Sexuality Education in Europe (WHO & BZgA, 2011) and is designed to be age-appropriate, with defined content for the first to thirteenth grades.

While the national curriculum provides a general framework for SexEd, each federal state has the autonomy to customize the federal curriculum (BZgA, 2018). Individual federal curricula vary in the duration and delivery of teaching, including integration into other subjects such as biology, religious education, social sciences, ethics, or as a stand-alone subject. Consequently, the coverage and depth of discussion on each topic vary among federal states and also among individual schools. For example, Weber (2023) found in her comparison between the curricula of Bavaria and North Rhine-Westphalia that the Bavarian guidelines are significantly more conservative regarding sexual diversity for example. According to the results of the “Youth Sexuality” representative repeat survey conducted by BZgA since 1980, the exposure to sexuality education lessons at school was 96% in the eastern states and 86% in the western states, as reported by adolescent respondents (Scharmanski & Hessling, 2022, p. 25). Additionally, the training of educators differs between federal states (BZgA, 2018). Teaching guidelines and mandatory educational materials are established by the Ministries of Education, while supplementary materials from BZgA, NGOs, and pro familia are also integrated.

Beyond the school setting, initiatives like NGOs aim to reach underserved youths at risk, employing various approaches such as multilingual information materials in diverse visualization formats along with professional training for youth workers (BZgA, 2018).

1.3 SexEd in Bavaria

The guidelines for family education and SexEd in Bavarian schools (Bavarian State Ministry of Education and Culture, Science and the Arts, 2016), which specify the content and teaching framework for SexEd in Bavarian schools, advocate comprehensive, interdisciplinary SexEd in the interests of a holistic approach. The aim here is to support "cognitive, social and communicative skills for dealing with sexuality as well as for partnerships and family life" (Bavarian State Ministry of Education and Culture, Science and the Arts, 2016, p. 3). The content is based on core topics such as human biology, gender roles and gender identity, self-concept and society, or the development of social and personal skills (State Institute for School Quality and Educational Research Munich, 2019, p. 18). In line with the demands of holistic SexEd, these subject areas go beyond anatomy and fertilization and emphasize the importance of sexuality as part of identity and interpersonal coexistence.

Nevertheless, these holistic guidelines do not appear to be taught to an adequate extent in everyday school life. National studies (Matthiesen et al., 2022) report that, despite positive developments, school-based SexEd still does not meet the needs of students. There are multiple reasons why (see Klein & Schweitzer, 2018 for an overview). For example, recent studies by the BZgA (Scharmanski & Mirza, 2023) show that although educational professionals attribute immense importance to SexEd, it is not addressed to a sufficient extent due to time constraints. Cooperation with parents can also hinder the appropriate implementation of holistic SexEd. Thus, the BZgA's findings indicate a mismatch between intended and implemented SexEd across Germany.

Looking specifically at the Bavarian guidelines and their practical implementation in Bavarian schools, two major things can be observed. On the one hand, the holistic approach in the Bavarian guidelines is handled more conservatively with an additional layer of organization (“Beauftragten für Familien und Sexualerziehung an der Schule”) than in other German guidelines, particularly concerning gender identity and lifestyles outside of heteronormativity (Weber, 2023). On the other hand, the practical implementation of the guidelines is limited, as teachers are usually reliant on their interests and skills when selecting content and teaching, rather than being prepared through in-depth training and further education (Hoffmann, 2016).

Although the Bavarian guidelines for SexEd do not fully meet the requirements of holistic SexEd, this more limited, conservative curriculum does not appear to be fully implemented in schools. Due to a lack of research on this discrepancy, in the attempt to investigate the gap between theory and practice, the following two-pronged research question was posed: What are the conditions for success and what are the hurdles in the theory-practice transfer of SexEd in Bavarian schools?

The research question was analyzed on two levels. Firstly, the Bavarian curriculum was analyzed, and the content was assigned to categories. Finally, a broad pool of experts from medical, scientific, therapeutic, and educational fields, as well as students and teachers, were asked about their assessments of the curriculum, their experiences, and their needs using semi-standardized interviews.

2. Methodological Approach to Analyzing the Theory-Practice Transfer in Bavarian SexEd-Lessons

2.1 Sample and Data

The sample consisted of two teachers, two students (both aged 15, one from a high school and one from a vocational school), one person from the State Institute for School Quality and Educational Research Munich, two scientists, two sex therapists, and one person who conducted SexEd workshops at schools as an external expert (see also. 2.4.1 Access to the research field and 5. Prospects for further research). All interviewees gave their written consent to the interview and processing of their data.

The interviews were conducted in person or virtually via the platform Zoom and recorded using a recording device or Zoom's recording function. All interviews were transcribed according to the semantic-content transcription system of Dresing and Pehl (2018, 20pp.). The transcripts were created manually in the transcription program f4 (v8; Dr. Dresing & Pehl GmbH, 2021). Semantic-content transcription rules were chosen to develop a “feeling” (Breuer, 2010, p. 68), i.e., predicting first directions and findings for the subsequent theory development. These rules ensured that the texts remained legible during the data analysis and that pauses or interruptions were also transcribed. Passages from the interviews are repeatedly quoted in this work. These have been adapted by the authors (without distorting the content) so that they fit into the flow of the text and do not impair readability (cf. Kowal & O'Conell, 2022).

All transcripts were pseudonymized (German Data Forum, 2020). To this end, each transcript received a code (e.g., s013), so that no conclusions can be drawn about the interviewees from the information in the references. A text reference looks as follows: (s010, pos. 35). Readers cannot recognize from the references which document the references come from, but only where they can be found in the text.

2.2 Methods and Analysis

2.2.1 Curriculum Analysis

In order to present the current status of theoretical SexEd in Bavarian schools and, in a second step, to work out possible advantages and disadvantages of the curriculum through selected experts, the official guidelines for family and SexEd in Bavarian schools (Bavarian State Ministry of Education and Culture, Science, and the Arts, 2016) were analyzed and divided into categories.

The categories, their descriptive statistics and the associated inter-rater reliability variables are shown in Table 1. The categories were formed inductively, i.e. categories were not defined in advance but emerged from the process (cf. Mayring, 2012). The categories were created by a first coder and the curriculum was then coded along these categories by the first coder and two other coders. In a first run, this resulted in 18 categories with the following foci: cis-normative, health, anatomic, biology, orgasm-gap, anti-abortion, monogamy, society and ethics, queer, sexual harassment, individual, relationship, pleasure, religion, equality, law, media, and consent. These categories were then further summarized, resulting in eight final categories: Relationship to others and society; relationship to self; media and pornography; consent and pleasure; body and health; religion; law; and cis-, hetero-, and mono-normativity (see Fig. 1).

2.2.2 Semi-Structured Interviews

In order to answer the research question appropriately, we applied the method of reflexive grounded theory. We deliberately opted for interviews as the main method, using both guided interviews and an interactive workshop with interested students for data collection. This scientific-methodological selection, supported by Breuer (2010, p. 58), enabled us to delve deep into the topic and ensure the necessary theory-practice transfer. The process follows an iterative structure: Collected observations and interviews were evaluated, then systematically categorized. The grounded theory methodolo-

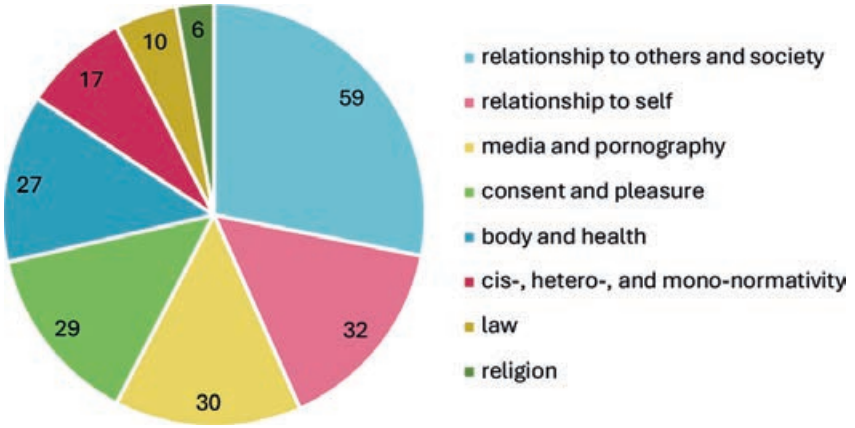


Figure 1: Categorization of the Bavarian Curriculum

A content point of the curriculum (e.g., "students name, gender characteristics of boys and girls", Bayerisches Staatsministerium für Bildung und Kultus, Wissenschaft und Kunst, p. 8) could take on several characteristics, i.e. several categories could be coded for one content point. The agreement of the coders fluctuated across all categories between small and excellent values (κ = .39—.96). Overall, there was a moderate coder agreement of κ = .68.

Category	Subcategories	M(SD)	κ		
			Coders 1 & 2	Coders 1 & 3	Coders 2 & 3
				κ (SD) 95 % CI [LL-UL]	
Body and health	- health - anatomic - biology	.18(.38)	.820(.61) [.70-.94]	.81 (.06) [.68-.93]	.83 (.06) [.72-.95]
Relationship to others and society	- relationship - society and ethics	.35(.48)	.59 (.07) [.46-.72]	.76 (.06) [.64-.87]	.72 (.06) [.61-.83]
Relationship to self	- individual	.20(.40)	.60 (.08) [.44-.75]	.64 (.08) [.48-.80]	.72 (.07) [.59-.86]
Consent and pleasure	- consent - pleasure - sexual harassment	.21(.41)	.60 (.08) [.45-.75]	.71 (.07) [.57-.84]	.69 (.08) [.54-.84]
Religion	- religion - anti-abortion	.04(.20)	.51 (.17) [.08-.73]	.49 (.22) [.05-.92]	.56 (.16) [.24-.87]
Law	- law	.06(.25)	.57 (.14) [.31-.84]	.83 (.10) [.65-.99]	.72 (.12) [.49-.95]
Cis-, hetero- and mono-normativity	- cis-normative - orgasm-gap - monogamy - queer - equality	.04(.18)	.55 (.16) [.23-.87]	.49 (.22) [.07-.91]	.39 (.19) [.01-.77]
Media and pornography	- media	.20(.40)	.94 (.04) [.86-.99]	.94 (.04) [.86-.99]	.96 (.03) [.90-.99]

Table 1: Categories of the Bavarian Curriculum, Descriptive Statistics, and Cohen's κ

gy (GTM) requires an open and adaptable attitude to react flexibly to new findings during data collection (Charmaz 2006, p. 178).

The guided interviews enabled us to enter into dialogues with experts from different fields and to understand different perspectives on the topic. The guidelines, with questions focused on our research interests, served as an orientation, whereby the focus was on the personal stories and experiences of the interviewees. This open and flexible approach allowed us to deviate from the prepared questions and emphasized our methodological approach of meeting all interviewees with as little bias as possible. After each interview, the key questions of the superordinate categories were supplemented, reformulated or deleted based on the results. This process allowed us to ensure the quality of our data. Based on our methodological approach (Grounded Theory Method) we created our own questionnaire. It contained various sets of questions based on our initial research (s. Tab. 2) and made an important contribution to the further acquisition of knowledge.

Nr.	Topic	Explanation
1	Personal connection & education and training	We wanted to get to know the interviewees on a more personal level and find out how they came to the topic of SexEd. This set of questions explains why this person was selected for an interview. Example: – Can you briefly introduce yourself and your area of work? – To what extent were you familiarized with the topic during your training?
2	Status Quo Curriculum	With this set of questions, we want to find out about the current content of the curriculum. In particular, what the respondents think is missing, important or over-emphasized in the guidelines. Example: – What are important topics in the curriculum? – What do students use outside the curriculum for their education?
3	Implementation of SexEd lessons	The focus here is on everyday teaching practice in Bavarian schools and how this ministerial directive is applied in the classroom. How important is this topic in schools in general or in the teaching staff? Example: – How is the topic of SexEd generally placed in schools? – How are these topics taught
4	Hurdles in the implementation of SexEd lessons	In contrast to the previous block of questions, this one is intended to illustrate the difficulties with the topic in lessons or at schools in general Example: – Why does the implementation of the curriculum not work? – 'Is there a topic that you feel uncomfortable or unsure about addressing in class?
5	The personal vision	In the last block of questions, respondents are asked to describe their dream vision for the future of successful SexEd. As the vision and reality may still differ. Example: – What does the perfect SexEd look like in the future?

Table 2: Questions of the Semi-Structured Interview

2.2.3 Workshop on SexEd

The workshop that took place during the weekend seminar served as field observation, as field notes were taken and a research protocol maintained, which played a role in the classification of the data. Additionally, the workshop highlighted how the most important target group - the students - currently perceive SexEd lessons and what changes they wish for. For the structure of the workshop, please refer to Table 3.

Nr.	Topic	Explanation
1	Introduce ERIK*A	As part of our engagement with TUMJA, we advocate for a renewal initiative focusing on contemporary SexEd, titled "sex education goes to school". We believe that the current SexEd curriculum may not adequately meet modern needs, despite its longstanding stability. Recognizing significant gaps within this stable framework, we aim to explore the reasons behind the stagnation in SexEd's development. To delve into this anomaly, we actively seek input from students, valuing their unique experiences and perspectives for effective teaching. In our discussions, confidentiality is paramount to foster open and genuine dialogue. We ensure participants' privacy by obtaining consent before any photographic documentation, omitting faces. Our goal is to cultivate a safe environment that encourages the free exchange of ideas and concerns.
2	Get-to-know-each-other	The participants are asked to answer the following questions in a short introductory round: Who am I? How am I doing today? One sentence, what have you already taken away from this weekend?
3	Curriculum analysis	In our research, we focused on four key areas of Bavarian SexEd: human biology; gender roles and identity; self-concept and social integration; and personal and social skills. These topics guide our approach. We segmented the content and distributed it among participants. Participants work in small groups to categorize and explain the content according to class levels. This method ensures thorough understanding and seamless integration into the curriculum.
4	Mutual exchange	After verifying the accuracy of class assignments, participants form groups of four, with each member responsible for a specific topic block. This structured approach fosters interdisciplinary exchange and in-depth discussion. During discussions, participants address specific questions: what aspects surprised or puzzled them, and whether they can relate the content to the existing curriculum. This structured reflection aids in understanding individual perspectives and evaluating the effectiveness of the teaching concept, identifying areas for improvement.
5	Experience exchange	In our research, we're collecting narratives from students about their experiences in SexEd classes. We specifically aim to gather their best, funniest, and worst anecdotes from school. This qualitative survey seeks to understand students' perspectives on SexEd lessons more deeply.
6	Collection of topics	Students independently select topics they believe are essential for an ideal SexEd class. These topics form the foundation for crafting a fictional curriculum that aligns with students' preferences and teaching methods. This participatory process ensures students' perspectives are fully integrated into the lesson planning, aiming to create a SexEd framework that meets their needs and expectations.
7	Poster Walk	In a participatory research initiative, students' chosen topics are transferred to flipcharts to visualize and structure the content systematically. Students then provide feedback on the posters, focusing on the requirements for including these topics in next year's SexEd lessons. Discussions cover aspects such as topic relevance, key questions, necessary conditions for implementation success, preferences for topic design, and required materials. This structured exploration provides practical insights into students' needs and expectations, aiding in identifying key factors for successful integration into SexEd lessons.

8	SexEd-Theatre	In our approach to creating a play centered on SexEd, we draw parallels with the diverse roles and responsibilities in theater. This comparison helps systematically identify the necessary roles for staging SexEd lessons. We carefully examine each role, focusing on assigned tasks and associated characteristics. We aim to determine relevant roles, individual participation opportunities they offer, and required character traits.
9	Fact sheets	Our research on advancing SexEd focuses on two key questions: renaming the subject and conceptualizing an ideal vision for its future development. Renaming SexEd requires careful consideration of its goals and content. We aim to create an innovative and inclusive term that encompasses both didactic and emotional aspects. Simultaneously, we outline a utopian vision for the future of SexEd, emphasizing progressive and inclusive teaching methods that reflect evolving social norms and needs. This vision includes gender-equitable content, participatory approaches, and extensive use of digital resources, serving as a model for optimal development within the evolving educational landscape.
10	Feedback	Everyone is allowed one sentence to say what they liked and what they took away from the workshop, and what they didn't like.
11	Interviews + email-list	We are still looking for interview partners for our qualitative data collection and are asking for the participants' emails so that we can contact them.

Table 3: Workshop Structure

2.3 The Process of Coding

The next step in data analysis and an essential component of the reflexive GTM is the coding of the collected data. In the reflexive GTM the researchers are in a constant interplay between their survey, the data and the coding (Strauss, 2004). Thus, this work step cannot be completed as a single work step. Initial coding findings affect the data collection through adapting the questionnaire or deepening a set of questions. The importance of the coding process and the development of essential categories has already been emphasized by Glaser and Strauss (1999, p. 23):

In the discovery of theory, conceptual categories or their properties are developed from evidence; then the evidence from which the category emerged is used to illustrate the concept. The evidence need not necessarily be unquestionably correct [...] but the concept is undoubtedly a relevant theoretical abstraction about what is going on in the domain under investigation. Moreover, the concept itself will not change, while even the most accurate facts will change. The meaning of concepts is only sometimes redefined because other theoretical and research purposes have evolved.

Many researchers who have followed this methodology have further developed the concept of the reflexive GTM; in their discussion of the reflexive GTM, they also emphasize coding as an essential step in their interpretative procedure for theory formation and divide it into open, axial, and selective coding (Berg & Milmeister, 2011; Breuer, 2010; Muckel, 2011; Pflüger, 2013).

To ensure comprehensibility and contribute to the desired intersubjectivity, Table 4 provides a brief overview of the superordinate categories, flanked by further explanations that shed more light on the methodological approach.

2.4 Reflecting on the Research Process

Self-reflection is a crucial criterion in qualitative research (Unger, 2014). This reflection specifically pertains to methodological reflexivity, which involves the researcher's conscious attention to their own position and role in the process of knowledge acquisition (Breuer, 2010). This section serves for reflection on the scientific process, access to the research field, and our role as researchers.

2.4.1 Access to the Research Field

Team ERIK*A arrived at the research topic through shared experiences of inadequate SexEd during their own school time. This shared experience was the starting point for questioning how their own sexual development would have changed if SexEd in schools had not been one-dimensional and solely focused on biology. Regarding access to the research field, a personal bias of the researchers

Main category	Description	Total Number of Coded Segments
Success conditions for holistic SexEd	ERIK*A's main research interest was analyzing how to ensure a successful SexEd in schools. This involves analyzing the personal, emotional and material aspects that are necessary for a modern SexEd and can lead to a successful SexEd.	36
Hurdles for holistic SexEd	This code is partly complementary to the conditions for success and outlines the problems and hurdles for a good and successful SexEd.	73
Status Quo of Bavarian SexEd	This category was primarily concerned with taking stock of the current practice of SexEd and how it is dealt with in schools. This included the general framework conditions in which SexEd takes place. What content that can be found in the curriculum is taught and what is missing in the curriculum according to the interviewees? This stocktaking also included looking at the resources available for SexEd. These may be human (skills, training etc.), material (methods, materials, external outreach programmes etc.) or social (suitable age for SexEd or the history and development of SexEd).	306
Institutions involved in SexEd	SexEd is a specialist area within school education that is controlled and influenced by various institutions. Who is responsible for SexEd and what influence do these institutions currently have? This includes the schools themselves, but also political institutions such as ministries.	67
Individuals playing a key role in SexEd	Individuals or groups of people influence the organization and success of SexEd, primarily those within the school, such as teachers and students. However, peers, parents, external service providers and society also have an influence on SexEd outside the school context.	132
Visions for future holistic SexEd	In the interviews, the status quo also always indicated the possibility that there is still potential for improvement. This category summarizes all the codes that indicate a possible development of SexEd in the future.	56

Table 4: Description and Total Amount of Coded Categories

can be observed, as they had mostly insufficient experiences with school-based SexEd to varying degrees. Access was further motivated personally and driven by personal experiences, including from personal networks in families and acquaintances. Despite this subjective access to the research field, theoretical and empirical literature was consulted for deeper exploration of the topic and, naturally, for generating the research question. Although strong emphasis was placed on objectivity when reporting and interpreting the interview results, the personal bias of the researchers should be kept in mind.

It was particularly important for the project team to include a diverse field of experts in the study. Scientists, therapists, teachers, political institutions, NGO workers, and especially students were intended to be part of the survey. We believe that the sample is diverse in terms of gender representation, age, professions, and access to SexEd. However, due to restricted availabilities and a structural lack of diversity that is reflected in homogeneous education and job placements, the goal of a sample that is also diverse in culture and religious backgrounds was not achieved. Further, as SexEd is a heavily socially charged issue, the majority of the interviewees had a very positive attitude towards comprehensive SexEd and were (professionally) engaged with sexuality and related topics, which is why the sample predominantly had an open, positive opinion towards the further development of SexEd.

2.4.2 The Research Process

To turn the idea into a proper research project within the framework of the TUMJA scholarship, the first phase of research was initiated to identify different dimensions of successful SexEd.

Following this, the question arose of how feasible it was to realistically implement and carry out the project with limited time

resources. The limitations of this work were based on the federal school system in Germany, access to personal networks, and experiences regarding SexEd in Bavarian schools. Making this important decision at the outset allowed for a clear project goal to be established, and the initial analysis phase was conducted using the Bavarian curriculum for SexEd. For this analysis, the official guidelines for family and SexEd in Bavarian schools were coded and evaluated (Bavarian State Ministry of Education and Culture, Science and the Arts, 2016). Surprisingly, the team found that these guidelines were extensive, contrary to the researchers' expectations.

Thus, the question arose about a gap that exists between the official teaching materials and the practiced curriculum. With this assumption in mind, various in-depth qualitative questions were developed in numerous workshops and eventually reduced to the most relevant ones.

It was particularly important to have clear task and role allocation within the team. For major decisions regarding the overall project, weekly meetings were held within the team, allowing for discussion. For more specific tasks such as contacting interviewees, conducting interviews, transcribing, coding the interviews, or even collectively writing individual chapters in the project report, small groups were formed based on availability and experience. This division of labor worked very well within the team and ultimately led to the successful completion of the project.

2.4.3 The Researchers' Roles

During the 20-month research process, the team engaged extensively with the topic of SexEd. One of the most important aspects was that the personal level of the team members played a crucial role in the success of the project. Mutual understanding and close collaboration motivated the team to passionately and diligently bring the project to a successful conclusion despite the challenges and time constraints.

Another key factor for the success of the research project was the personal interest and willingness of the members to engage with the topic scientifically. The project members brought their personal stories and experiences in the field of SexEd and developed a strong determination to present this topic more visibly and transparently in a scientific context.

Despite the awareness that this research can only make a small contribution to the current status quo of SexEd in Bavarian schools, it was important for everyone in the team to provide a stimulus for future improvement.

Furthermore, reflecting on their own role in the research field yielded interesting insights. Through self-reflection, team members were able to maintain their neutrality and objectivity, thus enhancing the credibility of the research findings. It would be interesting to further deepen this self-reflection and examine its impact on the research more closely.

3. Outcome of our Data Analysis

As methodological approaches are explained in depth in the previous section, the outcome of our data analysis will be presented in the following. The subsections are structured according to the categories presented in Table 2.

3.1 Curriculum

3.1.1 Development and Background

Since the establishment of SexEd in the school curriculum in 1969 (Researcher 2, pos. 30), social values and practices have changed considerably (ibid.). This calls for new guidelines and curricula (Researcher 2, pos. 32) that take greater account of topics such as sexual diversity (Researcher 2, pos. 32; Researcher 1, pos. 42) in order to do justice to current social developments and the need for more openness, sex positivity and tolerance (Researcher 1, pos. 42, 54; Researcher 2, pos. 24, 50). The State Institute for School Quality and Educational Research Munich (ISB) tries to meet these needs when compiling the curriculum by deploying a diverse team of experienced teachers for this task (Teacher 1, pos. 51).

3.1.2 Bavarian Curriculum

Looking at the Bavarian curriculum, there are a few suggestions for improvement and criticisms, according to our experts.

Currently, the implementation of the curriculum focuses on the biological aspects of sexuality, such as the anatomy of the sexual organs, the menstrual cycle, reproduction and embryonic development (Student 1, pos. 10; Student 2, pos. 12; Teacher 2, pos. 12; Teacher 3, pos. 24, 26), which may lead to the challenge of sexuality being equated exclusively with the biological function of reproduction (Researcher 1, pos. 18, 20, 52).

The inclusion of religion in SexEd is also criticized (Counsellor 1, pos. 18; Researcher 2, pos. 22) and religion should either be excluded (ibid., Counsellor 1, pos. 20) or critically scrutinized (Counsellor 1, pos. 20; Researcher 1, pos. 36). Instead, experts wish for an increased engagement with social science content, such as the ongoing hierarchization of heteronormativity and gender law (Researcher 1, pos. 32, 36, 38; Student 2, pos. 29) as well as more transparent and comprehensive teaching about gender, sexual diversity, and tolerance (Counsellor 1, pos. 6, 8, 18, 20; Researcher 2, pos. 22, 52).

Although the topics of gender identity and relationships with oneself are present in the curriculum (Counsellor 1, pos. 4), experts criticize a lack of content on self-discovery and self-esteem (Counsellor 1, pos. 4, 6; Researcher 2, pos. 56) and recognizing and demonstrating one's own needs and boundaries, including masturbation, consent, and sexual harassment (Counsellor 1, pos. 6, 18, 20; Counsellor 2, pos. 10, 20, 32, 34; Researcher 2, pos. 56; External Expert, pos. 101; Student 2, pos. 29).

Relationships with others are also an important topic that receives too little attention in the curriculum (Counsellor 1, pos. 6; Researcher 2, pos. 14, 24). This should include the different relationship styles and the connection between healthy or toxic relationships and mental health (Counsellor 1, pos. 6, 12, 14). Finally, love, desire and friendship in all interpersonal relationships should be addressed (Researcher 2, pos. 14, 24).

3.1.3 Implementation of the Curriculum in Bavarian Schools

Safe Space as a Framework Condition for Teaching

The experts consider it important to organize lessons empathetically, i.e. tailored to the needs of the students (Counsellor 2, pos. 24, 28; Student 1, pos. 18, 43, 56; Teacher 2, pos. 32). This particularly includes the creation of a so-called safe space, i.e. a confidential and protected environment in which students feel safe to share their thoughts, questions, and experiences without fear of judgement or condemnation (Researcher 1, pos. 54; External Expert, pos. 58, 70, 81).

Teachers in particular play a decisive role in creating these spaces. This requires an open attitude for teachers so that students feel safe to ask questions and discuss free of prejudice and judgement (Counsellor 2, pos. 12, 28; External Expert, pos. 81; Student 1, pos. 37; Teacher 2, pos. 24). In order to enable such a safe space, SexEd should already be dealt with in depth during teacher training to provide them with the necessary skills (Counsellor 2, pos. 12; Researcher 2, pos. 50, 52, Teacher 2, pos. 16).

In addition, a good relationship with the students is important in order to deal with topics in a more in-depth and comprehensive manner (External Expert, pos. 66) and to create a safe space for this exchange (ibid.; Student 1, pos. 59; Counsellor 2, pos. 10, 32; External Expert, pos. 58). Suggestions for improvement included teaching in small groups (Teacher 2, pos. 50) and a school forum with permanent contact with persons outside the classroom (Counsellor 2, pos. 36).

Methods and Implementation

In general, the student experts are dissatisfied with the current structure of SexEd, stating that the sustainable teaching of content that is important for students is heavily dependent on the individual teachers responsible for it (Student 1, pos. 35; Student 2, pos. 29).

Some experts favor gender-segregated courses as a teaching method (External Expert, pos. 8; Teacher 3, pos. 32, 39; Researcher 1, pos. 54), as SexEd can be used to specifically address the different genders (External Expert, pos. 8) and offer students a safe space for their questions and concerns (Researcher 1, pos. 54; Teacher 3, pos. 39). In order to prevent the reproduction of a gender binary, lessons should be open and designed with options for students (Researcher 1, pos. 54).

To support teachers, the ISB provides handouts with information and teaching examples (Teacher 2, pos. 12, 34; Teacher 1, pos. 5). However, there is uncertainty among teachers which materials may be used for legal and ethical reasons (Teacher 3, pos. 8).

External Access

While students might seek information on SexEd from their parents (Counsellor 1, pos. 20; Teacher 3, pos. 18; Student 2, pos. 21) or friends and older siblings (External Expert, pos. 36; Student 1, pos. 24; Teacher 2, pos. 14), the internet and social media act as the main access point for sexual topics outside of school (Counsellor 2, pos. 10, 22, 32; Researcher 2, pos. 54; External Expert, pos. 36; Student 2, pos. 21; Teacher 2, pos. 14). Students should be supported during SexEd lessons in dealing with various media;

in particular, pornography should be addressed in an educational way (Counsellor 1, pos. 20; Counsellor 2; pos. 34)

Age/Grade Level

The decisive factor for competent SexEd is a process-orientated approach to teaching, adapted to the respective age of the students (Counsellor 2, pos. 10; Researcher 1, pos. 48). It should be avoided that students are made aware of various topics too early or too late and they ought to be informed comprehensively (Counsellor 1, pos. 10; Counsellor 2, pos. 10; External Expert, pos. 6; Student 2, pos. 44; Teacher 3, pos. 26, 28, 30, 39). A start in kindergarten, at the latest during primary school, would be best (Counsellor 2, pos. 10).

People and Institutions Involved

SexEd plays an important role both institutionally and personally. The school as an educational institution (Counsellor 2, pos. 10) and place of identity formation (ibid., pos. 36, 40; Researcher 2, pos. 50; Student 2, pos. 53) plays a special role - however, SexEd does not play an equally important role in the school (Teacher 3, pos. 24). Although there is cooperation between school boards and students at some schools, for example when students want to push through their demands for more SexEd (Teacher 1, pos. 9) or free hygiene products in toilets (Teacher 1, pos. 87), the topic of SexEd is still stigmatized at other schools (Counsellor 1, pos. 24).

The experts place particular responsibility on the teachers. In order to realize sustainable SexEd, they must show openness, commitment and initiative (Counsellor 1, pos. 24; Counsellor 2, pos. 24, 34; Researcher 1, pos. 46, 48; Researcher 2, pos. 50; External Expert, pos. 62; Student 1, pos. 18). The competence and interest of the teacher strongly influence the framework conditions, trust and well-being of the students: "I think [no teacher] somehow tried to convey this seriousness [of the topic] in a comprehensible way." (Student 1, pos. 47). Some experts, including teachers, therefore also doubt whether teachers are even suitable to teach SexEd due to their relationship with the students and the associated lack of anonymity (Counsellor 1, pos. 16), their own shame (Counsellor 2, pos. 12), excessive demands (Teacher 2, pos. 40), or insecurities when teaching difficult topics (Teacher 2, pos. 10). Instead, schools should rely on external specialists such as licensed sex therapists or social workers (Counsellor 1, pos. 16, 18, 24; Counsellor 2, pos. 34; Researcher 1, pos. 46, 54; Researcher 2, pos. 32; External Expert, pos. 2, 4, 50; Student 1, pos. 30, Teacher 3, Pos. 39; Teacher 2, Pos. 50). It would provide "a safe space if you have other people there than the person who always grades" (Researcher 1, pos. 54, 56) and enables unbiased exchange with and between the students (Counsellor 1, pos. 16). Collaboration would not only make it easier for less trained teachers (Teacher 2, pos. 22; Teacher 3, pos. 39) but is also demanded in part by the students (Teacher 1, pos. 87).

However, teachers are not solely responsible for teaching SexEd. According to the Basic Constitutional Law, the right to educate is shared between schools and parents (Teacher 1, pos. 49). Some experts believe that such cooperation is essential (Counsellor 2, pos. 20; Teacher 2, pos. 50) and all experts agree that parents act as models that can either stigmatize SexEd (Counsellor 1, pos. 18, 20, 24), for example through religious beliefs (Counsellor 1, pos. 20; Teacher 1, pos. 49; Teacher 2, pos. 12; Teacher 3, pos. 37), fears (Researcher 1, pos. 48) or fear of losing control (Researcher 2, pos. 72), or can contribute to a dissolution of the taboo (Counsellor 2, pos. 32; External Expert, pos. 34; Student 1, pos. 20, 28; Student 2, pos. 21, 23). Accordingly, some experts report that students are increasingly being informed by their parents (Counsellor 2, pos. 10; External Expert, pos. 34; Student 2, pos. 21; Teacher 2, pos. 12), albeit to varying degrees: "Almost half [...] talk very, very, very, very openly [...] with their parents about it, but I think that a lot of them have simply never heard anything like that" (Teacher 3, pos. 18). Such varying degrees of SexEd are not only due to the divergent attitudes of parents towards SexEd but also to the individual development of the students (Counsellor 1, pos. 10; Researcher 1, pos. 48). The experts emphasize sexuality as a part of students' identity (Researcher 2, pos. 24, 30, 54, 56), which is also reflected in the great interest and "surprisingly well-founded questions" (Teacher 2, pos. 24) of the students.

Both inside and outside of school, students would discuss and experience SexEd with their peers (Counsellor 2, pos. 18; Teacher 2, pos. 14). However, this experience can also be negative and people are bullied for topics such as menstruation or their sexuality (Student 2, pos. 51). This is due to the prevailing social stigmatization of SexEd, which needs to be revalued (Researcher 2, pos. 24, 30, 54, 56; Student 2, pos. 51).

However, such a valorization is difficult given the political and social situation. Scientific experts report an instrumentalization of SexEd

(Researcher 2, pos. 32, 54) and repression of school SexEd due to a strong link between "a government that is very much about representing conservative values" (Researcher 2, pos. 54) and the Christian church (Researcher 1, pos. 48; Researcher 2, pos. 54). There would be a "politicization of the topics of gender, sexuality and family" (Researcher 2, pos. 54), because children could be used well as a moral resource (Researcher 2, pos. 32).

The experts therefore see the school, external specialists, teachers, and parents as responsible for teaching a holistic SexEd approach but complain about the excessive influence of social stigmatization based on conservative and religiously influenced government policies.

3.2 Conditions for Success and Hurdles

The main conditions for success and the hurdles the interviewees reported are described in the following and visualized in Figure 2.

3.2.1 Conditions for Success

The experts identified key aspects that can contribute to the success of a holistic SexEd (see Fig. 2). In particular, the aspect of time that is planned for it plays a central role in successful SexEd (Student 1, pos. 18; Student 2, pos. 16; Teacher 1, pos. 87; Teacher 2, pos. 18; External Expert, pos. 58, 115). The main issue here would be to allow sufficient time (Student 1, pos. 18; Student 2, pos. 16) or significantly more time for SexEd in the school year (Teacher 1, pos. 87; Teacher 2, pos. 18; External Expert, pos. 58), but also to offer SexEd at regular intervals, continuously over the entire school career (External Expert, pos. 58, 115).

Furthermore, teachers need to be open and sensitized to the issues to successfully implement SexEd in schools (Counsellor 2, pos. 12; Researcher 2, pos. 54; Student 1, pos. 18; Teacher 2, pos. 12, 42). Additional intrinsic motivation also contributes to a suitable learning environment (Counsellor 2, pos. 12; Teacher 2, pos. 12).

Scientific and external experts also called for the biology-based focus in SexEd to be expanded to include relevant topics from science (Researcher 1, pos. 36; Researcher 2, pos. 50) and life practice (Researcher 2, pos. 56; External Expert, pos. 16). The lessons should also cover sociological aspects (Researcher 1, pos. 36) and deal with current scientific findings (Researcher 2, pos. 50). Supplementing SexEd with a presentation of sexuality as "a positive, pleasurable topic" (Researcher 2, pos. 56) and making the prevention of sexualized violence and abuse (Researcher 2, pos. 56; External Expert, pos. 16) part of the teaching content is also essential (ibid.).

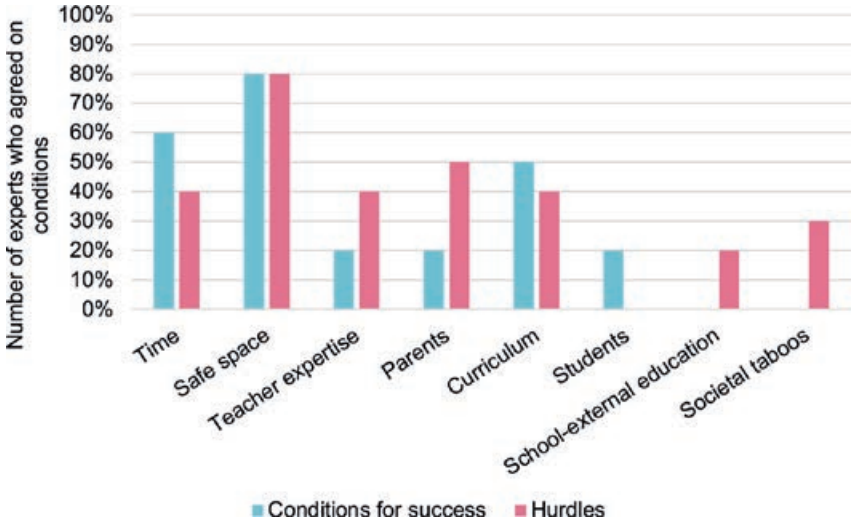


Figure 2: Conditions for Success and Hurdles According to Interviewees

Note. Safe space = attentive, open attitude of teacher. Curriculum = topics in the curriculum and support by the State Institute for School Quality and Educational Research Munich (ISB) that creates the curriculum.

Overall, lessons must be designed in such a way that SexEd units generate a safe space for teachers and students (Counsellor 2, pos. 28; External Expert, pos. 8, 10; Teacher 2, pos. 26, 32) which requires a relationship of trust between students and teachers (Teacher 2, pos. 26, 32). Cooperation with parents can also have a positive influence on SexEd (Counsellor 2, pos. 20; Teacher 1, pos. 49), as they could set an example of an open approach to SexEd-related topics in the family (Counsellor 2, pos. 20) and thus complement the work of the school. The direct involvement of students and their needs in the organization of lessons (External Expert, pos. 115) and the adaptation to the concrete reality of students' lives (External Expert, pos. 32) are also of great importance. Teachers need a comprehensive range of resources (Teacher 1, pos.51), especially well-founded teaching examples (Teacher 2, pos.12).

3.2.2 Hurdles

However, the experts also cited points that could complicate the implementation of SexEd in schools and manifest themselves as obstacles to the transfer of theory into practice (see Fig. 2). Scientific and teacher experts saw the parents of the students as a potential hurdle (Researcher 1, pos. 42, 44, 48; Researcher 2, pos. 72; Teacher 1, pos. 49; Teacher 2, pos. 34; Teacher 3, pos. 37). One reason for this is the personal (Teacher 1, pos. 49; Teacher 3, pos. 37), i.e. religious and political (Teacher 1, pos. 49) background of the parents, which influences the planned lessons (Teacher 3, pos. 37), Another reason is the rejection of specific teaching content by the parents (Teacher 2, pos. 34; Researcher 1, pos. 44). Parents' fear of the effects of SexEd (Researcher 1, pos. 48) and of a loss of control (Researcher 2, pos. 72) also has a negative impact on the implementation of theoretical content in practical lessons.

Most of the experts, including teachers, also saw the teachers as a potential obstacle (Counsellor 1, pos. 18; Counsellor 2, pos. 10, 12; Researcher 2, pos. 32, 50, 54; External Expert, pos. 10; Student 1, pos. 45; Teacher 2, pos. 6, 10; Teacher 3, pos. 16, 26, 37). On the one hand, teachers lack the necessary objectivity and distance to the teaching content (Counsellor 1, pos. 18; Teacher 3, pos. 16), which also makes it difficult to select the content (Researcher 2, pos. 50, 54). On the other hand, they lack an objective attitude towards and personal distance from the students (Researcher 2, pos. 32). This is because it is questionable whether "you want to talk about your own sexual fears and desires in front of the maths teacher, who also grades you" (Researcher 2, pos. 32), or, conversely, whether you want to hear about a teacher's "messed-up sex life" (Counsellor 1, pos. 18). Teachers handling certain topics shamefully due to personal circumstances also plays a role here (Counsellor 2, pos. 10, 12) and contradicts the teacher's objective handling of these topics (ibid.). Finally, the personal attitude of the teacher also influences objectivity (Counsellor 1, pos.18; Teacher 3, pos. 16). For example, the topic of abortion is "also more of an ethical and moral question" (Teacher 3, pos. 16), which could not be answered without the inclusion of personal opinions (ibid.).

The teachers' lack of expertise also has an impact on the quality of SexEd (External Expert, pos. 10; Student 1, pos. 45; Teacher 2, pos. 6, 10; Teacher 3, pos. 26, 37). This leads to uncertainty on the part of teachers regarding legal issues, what is permitted in the classroom (Teacher 3, pos. 26, 37), or to stigmatization (Student 1, pos. 45) or even avoidance of certain teaching content (External Expert, pos. 10). The existence of necessary prior knowledge when assigning a SexEd teaching task is also generally not checked in advance (Teacher 2, pos. 6).

The experts also saw potential hurdles in terms of the curriculum and the associated institutional support (Researcher 1, pos. 16, 20, 48, 56; External Expert, pos. 10, 12; Student 2, pos. 12; Teacher 1, pos. 9, 35, 47, 51). Mainly, the political orientation of the issuing authority already influences the selection and proportion of topics in the curriculum, since due to the "politics, which [...] in Bavaria is characterized by Christian conservatism, [...] certain topics [...] are given a lot of space compared to others" (Researcher 1, pos. 48). Biological aspects of SexEd could also be included in biology lessons (Researcher 1, pos. 20) and thus create space for non-biological topics (Student 2, pos. 12). In contrast, SexEd should be completely kept out of other subjects, such as religious education (Researcher 1, pos. 56).

Scientific and teacher experts also stated that the curriculum is not suitable for practical use (Researcher 1, pos. 16), as it does not contain any information for teachers about responsibilities and specific procedures (External Expert, pos. 12; Teacher 1, pos. 9). As the curriculum can only be updated every 13 years on average (equals one school career from the first to the final grade in high school), current SexEd topics cannot be covered promptly (Teacher 1, pos. 51). A special feature of the curriculum that stands in the

way of a smooth transfer of theory to practice is a clause in the guidelines that makes it compulsory to provide information and a right of co-determination for SexEd lessons, which does not exist in any other school subject (Teacher 1, pos. 35, 47).

In addition to the points mentioned, the time factor was also seen as an obstacle by student and teacher experts (External Expert, pos. 8; Student 2, pos. 35; Teacher 1, pos. 35, Teacher 2, pos. 24, 35). On the one hand, too little time is set aside for SexEd in the overall curriculum across different subjects (Teacher 3, pos. 24, 35), but teachers also actively allow themselves too little or no time for SexEd (Teacher 1, pos. 35; Student 2, pos. 35). A lack of time, in turn, means that the needs of the students cannot be addressed and that it is not possible to establish the contact necessary for the lessons (External Expert, pos. 8). However, this establishment of contact is necessary to create a safe space (Teacher 2, pos. 26, 36). Even if teachers did not actively regulate the climate in the classroom during SexEd, there would be no safe space (Student 2, pos. 44), bullying would occur (Student 2, pos. 51) and students would not feel taken seriously (Student 1, pos. 43). The absence of a safe space could also become a hurdle in practice (Counsellor 2, pos. 28).

The way society as a whole deals with SexEd-related topics can also have a negative impact on the transfer from theory to practice (Researcher 1, pos. 42, 46; Researcher 2, pos. 54; Student 2, pos. 25). For example, the social taboo on sexuality also influences the students' circles of friends: Sexuality becomes a topic that "people don't like to talk about [...] and if [...] then [they] immediately get kind of funny looks" (Student 2, pos. 25). If SexEd topics are discussed among peers, with siblings and friends or in the school playground, this often leads to premature and misguided SexEd among children and adolescents (Counsellor 1, pos. 18; Teacher 2, pos. 12, 14, 16, 34). The sometimes unsupervised use of the internet, social media and pornography also contributes significantly to this (Counsellor 2, pos. 10, 18; Teacher 2, pos. 14, 16). Parenting with varying degrees of openness also leads to diverse educational levels among children in the same age group (Teacher 2, pos. 34), but the curriculum does not provide any room for maneuver in this regard (Teacher 2, pos. 12), as it is not based on the needs and the level of education of children and young people, but only on grade levels (Teacher 2, pos. 12).

3.3 Visions

It is emphasized that SexEd is essential and should take up a larger part of the curriculum in order to enable destigmatizing and diverse SexEd (Counsellor 1, pos. 6, 8, 14, 18; Counsellor 2, pos. 14, 16, 22; Researcher 1, pos. 66, 68). The need for early and continuous SexEd (Counsellor 2, pos. 32; Teacher 3, pos. 39) is emphasized in order to promote open communication and better understanding (Counsellor 1, pos. 8, 24; Counsellor 2, pos. 34; Researcher 1, pos. 54; External Expert, pos. 111). There is a desire for a broader and more inclusive approach to SexEd that considers not only biological aspects (Researcher 1, pos. 18; Teacher 1, pos. 93) but also social science perspectives (Counsellor 1, pos. 18; Researcher 1, pos. 36; Student 2, pos. 29, 31). The necessity of upgrading the topic of SexEd is emphasized, both through better training of teachers and through stronger anchoring in teacher training (Researcher 2, pos. 50, 52, 56). It is noted that structural obstacles such as a lack of financial and personnel support as well as a lack of male specialists in this area must be overcome (External Expert, pos. 111; Teacher 1, pos. 93; Teacher 3, pos. 39). Students express the desire for a safe space for open discussions and questions (Counsellor 2, pos. 28; Researcher 1, pos. 54; Student 1, pos. 54) that is free from discrimination and shame (Counsellor 2, pos. 32; Student 1, pos 56; Student 2, pos. 55). External professionals who are not tied to a specific subject could play a positive role in SexEd (Counsellor 1, pos. 18; Researcher 1, pos. 54; Teacher 2, pos. 50). Greater involvement of parents and improved infrastructural support in order to be able to work in small groups is considered desirable (Counsellor 2, pos. 32; Teacher 2, pos. 50).

4. Discussion

From these findings, clear opportunities and risks can be derived for a meaningful and beneficial SexEd for the students. All the factors identified have the potential to tip the scales in one direction or another and to act either as an obstacle or a prerequisite for the successful transfer of theory to practice. One of the main sticking points seems to be the existence or non-existence of the safe space. This is congruent with previous findings on the appeal of the internet for adolescents' SexEd-related questions, as it grants exactly the safe space they miss in school (DeHaan et al., 2012; Holstrom, 2015; Simon & Daneback, 2013). The extent to which it is actually possible to generate a "safe space" in the school must

be questioned at this point. Despite far-reaching changes in the system, it will probably only be possible to create a "safer space" at best, i.e. an environment that cannot guarantee openness and respect, but can at least reinforce them.

To contribute to the creation of such safer spaces, the framework conditions in which SexEd is carried out can be used as an example. The experts are in favor of both gender-segregated and mixed lessons but tend to favor the gender-segregated approach due to the better classroom climate. This is mirrored in international research that claims gender-segregated SexEd-classes to be slightly more advantageous when compared to mixed SexEd lessons (Jackson & Smith, 2000; Strange et al., 2010). The dilemma of choosing between segregation and mixing could be resolved by giving SexEd more time in general and thus providing the opportunity for both segregated and mixed lessons. In order to prevent the reproduction of a gender binary, the choice of "group" should be up to the students.

Furthermore, consideration should be given to not having the SexEd conducted by the (grading) teacher, but rather outsourcing it to external experts with the necessary prior training and pedagogical expertise. In case teachers lack the personal distance and objectivity to SexEd topics, certain topics may be avoided or selected subjectively. This is one of the reasons why SexEd varies from school to school.

A lack of openness and attentiveness also leads to a lack of the necessary safer space in lessons. If teaching cannot or should not be outsourced, teachers must be adequately trained in this area. Making SexEd part of the teacher training program and also training teachers' pedagogical skills with regard to the sometimes very sensitive topics of SexEd seems essential in this context (cp. Hoffmann, 2016). There should also be regular opportunities and obligations for further professional development. In this context, the ISB can also provide support. Teachers could be supported by a generous range of teaching materials and examples.

In addition, the time factor, which is (not) provided for SexEd, also plays a key role in its success. Prior research supports this by showing that even if teachers do show the necessary interest in teaching holistic SexEd, their efforts are constrained by the inefficient time that is made up for SexEd in the curriculum (Schwarmanski & Mirza, 2023). Allowing sufficient time for SexEd in the school year and ensuring that lessons are continuous, starting in Grade 1 and continuing until the end of the school biography, can ensure that students receive well-founded SexEd.

On the other hand, a lack of time means that important topics are not covered and the safe space that is so important for everyone involved cannot be created. It is better to plan more time than to cut back on the range of topics. SexEd in schools, which in practice is usually limited to biological aspects, should urgently be supplemented with sociological aspects and the latest scientific findings. However, this is not possible on the curriculum side due to the lengthy development process of 13 years on average. Consideration should therefore be given to giving teachers more room for maneuver to incorporate current aspects into lessons independently and thus react more flexibly to a rapidly developing cultural and media landscape.

SexEd tailored to the needs of students would also be made possible by giving them more freedom in the organization of teaching units. To make this possible, consideration must be given to whether parents' right of co-determination on the topics covered in lessons could be abolished. This is because the personal socialization of parents can have an impact not only on how their own children deal with sexuality, but also on entire classes or year groups by restricting the topics taught. This is in stark contrast to the right of children and young people to information and, in the worst case, leads to a persistent or intensified stigmatization of sexuality. Yet it is precisely the destigmatization and positive linking of SexEd-related topics that should encourage young people to come to terms with their own sexuality and all aspects associated with it, thus making schools a place for social change. In conclusion, it should be noted that there are two categories of factors in relation to successful SexEd: on the one hand, hurdles to or conditions for success, which are transformed into one form or another by those involved (students, teachers, parents, etc.) and can thus be directly influenced, and, on the other, genuine weaknesses, both in theory and practice, which can only be resolved from the institutional and societal side.

5. Prospects for Further Research

This scientific project builds a great foundation for further research based on our data. In the future several other experts from different backgrounds should be integrated into a follow-up study due to their insights and perspectives. In the future several perspectives should be integrated into a following study due to their insights and perspectives. At one point of the project, we had to raise the question of theoretical saturation (see Breuer, 2010; Kiener & Schanne, 2001). When is a sufficient "optimum" of data reached? The more data are collected, the more new aspects or even fields can be opened up. After explicitly weighing up the benefit (time) cost factor within the project team, the decision was made that the existing data would lead to a representative and valid result to build further research on. In order to complete the data set, it would have been advantageous to speak with students and teachers of all types of schools (like vocational schools, grammar schools, Waldorf schools, comprehensive schools, etc.), parents, institutional decision-makers, and representatives of church institutions.

6. Summary

The following statements sum up the most important aspects of the presented findings of SexEd in Bavarian schools and highlight possible implications for practice.

1. *Diversity of content and contact persons:* SexEd exceeds biological aspects. Topics such as relationships, gender identities and emotions are important. There is a need for contact persons and contact points for students, especially if the parental home does not provide sufficient support.

2. *Taboo and stigmatization:* Sexuality is still highly taboo and associated with insecurity and ignorance, especially for girls. Shame and insecurity make it difficult to deal with the topic in a school context.

3. *Need for a more open approach:* Professionals and students argue for a more diverse and open approach to SexEd that recognizes and respects the diversity of human identities and experiences.

4. *School implementation and resources:* The implementation of SexEd in schools depends on several factors, including the availability of resources, teacher training and the creation of appropriate learning environments.

5. *Involvement of the students:* Students play an active role in the design of lessons. Their questions and interests influence the topics and the course of the lesson. An open atmosphere in which students can ask questions is important.

6. *Focus on self-determination and respect:* A central aspect of SexEd is educating students to become sexually self-determined people who respect their own and others' boundaries.

7. *Challenges and needs:* Teachers face challenges such as limited resources and the difficulty of doing justice to sensitive issues. There is a need for better support and resources for teachers to deliver lessons effectively.

8. *Critical reflection and adaptation:* Lessons need to be continually evaluated and adapted to meet the needs and interests of students. A flexible and process-oriented approach is emphasized. ■

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Self-Reflection ERIK*A

How does one come up with the idea of dealing with sex education? That was relatively simple. To summarize briefly, it was a shared interest on the one hand and we had the framework and the opportunity to tackle it in a research project on the other.

Our ERIK*A research project began as a very small team of two people. Our personal memories and bad experiences in the field of sex education during our own school days motivated us to do something on the subject during our scholarship at TUMJA.

Between the kick-off weekend and the second seminar at the Schlierseealm, the team grew to five members who joined forces to conduct qualitative research on the topic of sex education in Bavarian schools. This qualitative approach to the study was a novelty within TUMJA, as it was the first of its kind in its history. As a result, we were repeatedly confronted with hurdles and challenges that did not immediately find an answer within TUMJA.

As I said, the decision to deal with the topic of sex education was influenced by the similar stories from the team members' own sex education lessons, despite the different school backgrounds and the age difference within the team. The first realization was that everyone's own SexEd at school was largely inadequate and insufficient – at most levels.

This shared experience formed the starting point for the question of how our own sexual development would have changed if sex education in schools had not been one-dimensional and focused exclusively on biology. Another decisive factor for the success of the research project was therefore, among other things, the personal interest and willingness of the members to deal with the topic scientifically. We wanted to make this topic more visible and transparent in a scientific context.

In order to turn the idea into an appropriate research project within the framework of the TUMJA scholarship, the first phase of the scientific process was initiated to identify various dimensions of successful SexEd. The first question that then arose was what realistic standards we needed to set in order to realize a well-rounded and completed project within 20 months. We therefore first defined our research area precisely. We focused on Bavarian schools, as the federal school system in Germany meant that local access seemed the easiest to achieve. In addition, we had numerous networks in this area that we could use for our research work due to our careers and degree programs. The decision to determine our resources and limitations from the outset made it possible to define a clear project objective. Our first phase of analysis then followed and we focused on the Bavarian curriculum for SexEd. For this analysis, we coded and analyzed the official guidelines for families and sex education in Bavarian schools. Surprisingly, we found that these guidelines were more comprehensive and detailed, contrary to the researchers' expectations.

Thus, we had to ask ourselves how our experiences could deviate so much from the possible theory. There must have been a gap between the official teaching materials and the practiced curriculum. With the assumption of a gap between theoretical specifications and practical implementation in mind, various qualitative question categories for different target groups were developed in several workshops and constantly developed, supplemented or modified in an iterative process. For us as a team, it was particularly important to have a clear division of tasks and roles within ERIK*A right from the start. For important decisions within the overall project, weekly team meetings were held to facilitate discussions. For more specific tasks such as contacting interview partners, conducting interviews, transcribing, coding the interviews or even writing individual chapters in the project report together, small groups were formed based on availability and experience. This division of labor worked very well within the team and ultimately led to the successful completion of the project.

Another important concern for us was to involve as diverse a group of experts as possible in the study. Scientists, therapists, teachers, political institutions, employees of non-governmental organizations and, in particular, pupils were to take part in the survey. We believe that the sample was successful in terms of gender representation, age, professions and access to sex education. However, we would have liked to have reached a wider range of different groups of

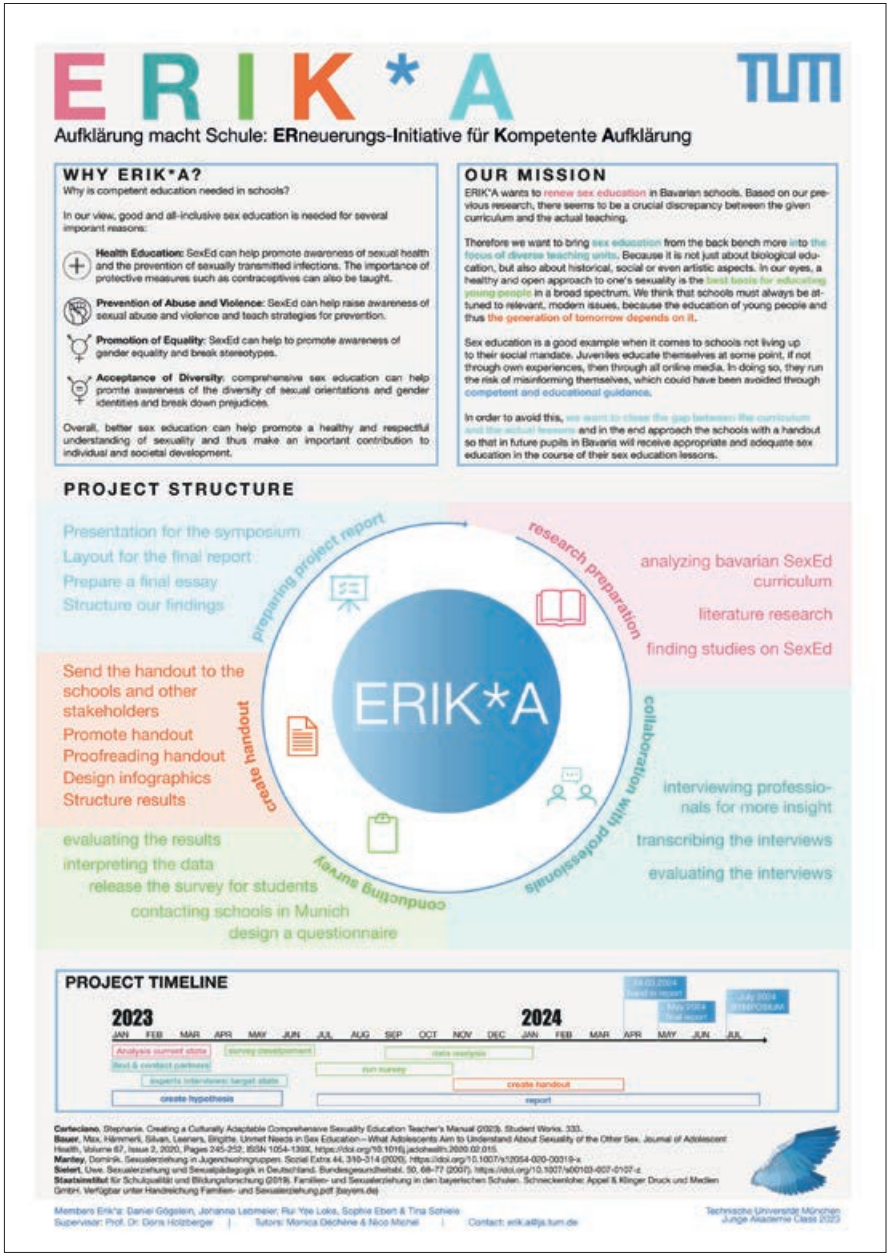
people. Our sample lacks perspectives from religious representatives and parents. In addition, most interviewees had a very positive attitude towards comprehensive sex education and were (professionally) involved in sexuality and related topics, which is why the sample predominantly had an open, positive opinion on the further development of sex education. We are aware of this bias and suggest that in a future follow-up study, these perspectives will provide a valuable addition that we were unable to capture in our research project.

Another hurdle that materialized during the course of the project was the complexity of the topic of SexEd and the different perspectives of the participants made the analysis and interpretation of the data challenging. Despite these difficulties, it was important to maintain the objectivity and neutrality of the research process in order to ensure the credibility of the results. Recognizing and reflecting on these challenges and limitations were crucial for the further development of the research project and the identification of potential improvements for future studies.

During the research process, important insights were gained that provide an outlook for future developments. A key finding was the need for more comprehensive and contemporary SexEd that goes beyond a purely biological perspective. It also became clear that a variety of experts and stakeholders should be involved in the design of SexEd programs in order to take different perspectives and needs into account. Despite the positive attitude of many interviewees towards comprehensive SexEd, there was also a need for critical reflection on existing programs and practices. The findings from the study suggest that greater integration of topics such as gender equality, diversity and consent into the SexEd curriculum is needed. Furthermore, it became clear that active participation of students in the design of the teaching process plays an important role in order to adequately address their needs and interests. An outlook on future developments shows that further research and practical work is needed to continuously improve the quality and effectiveness of SexEd programs. There is an opportunity to explore innovative approaches and share best practice to promote the sexual health and wellbeing of young people in a sustainable way.

Despite the dedication and passion of the team, we realized that our study commitments, PhDs, degrees and also our full-time jobs, hugely limited the time and resources available for the project. Nevertheless, we were determined to make a contribution to improving SexEd in Bavarian schools and to make the relevance of this topic transparent. To a certain extent, self-reflection was a constant companion during the research process, as the chosen ‘Reflexive Grounded Theory Methodology’ constantly scrutinizes and questions the role of the researcher, the approach to the field and the course of the research process. In this way, our method made it possible to question our personal motivations and insights again and again and to adapt them if necessary.

We are fully aware that this research can only make a small contribution to the current status quo of SexEd in Bavarian schools. Nevertheless, it was important to us as a team to provide an impetus for future improvements.



POSTER 1:

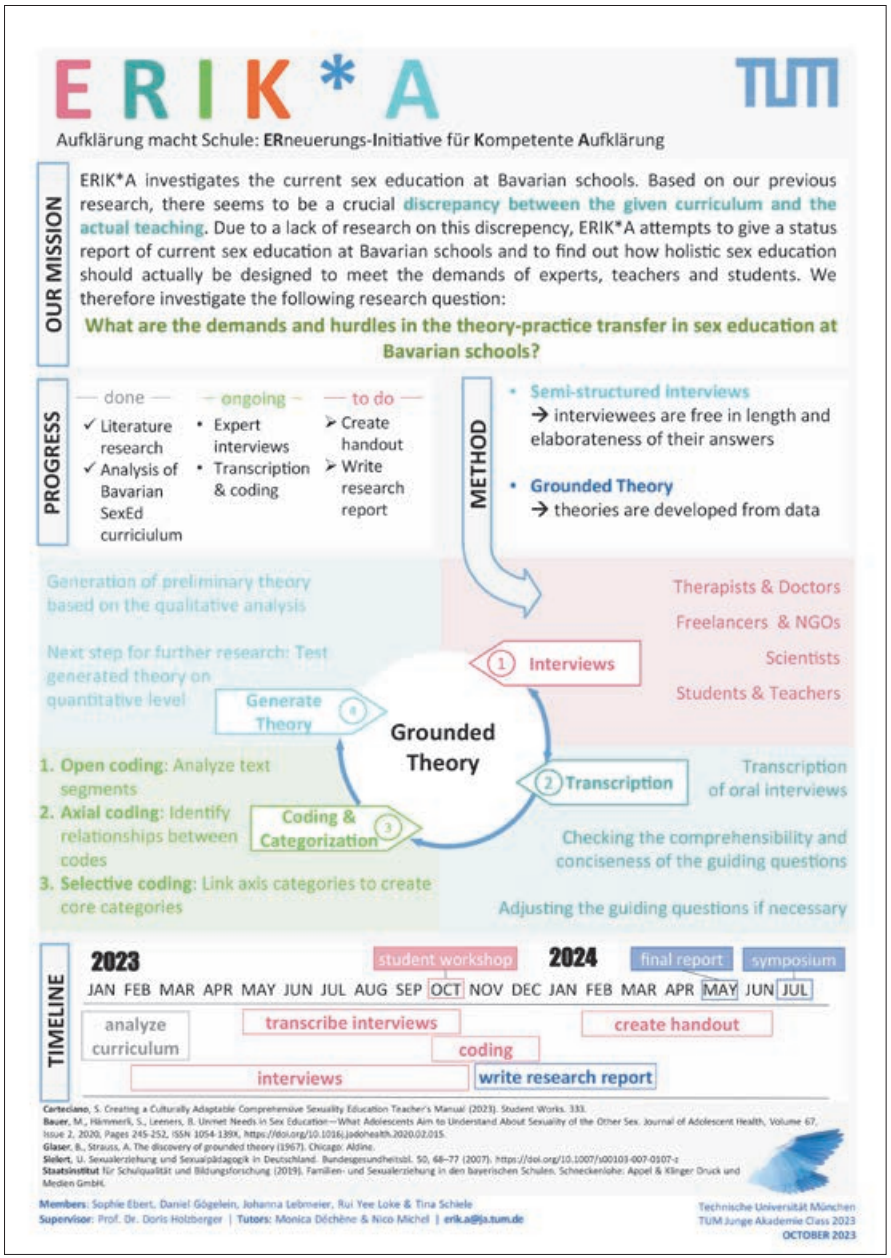
Drawing on previous personal experiences and on detailed research, our project has identified a significant gap between existing curriculum specifications and actual teaching. With the vision of bringing sex education to the forefront of diverse teaching units, we would like to emphasize that sex education goes beyond the biological aspects and should also embrace historical, social, and even artistic dimensions.

Good and inclusive sex education serves several critical purposes:

1. Health Education: SexEd raises awareness about sexual health, educating individuals about preventing sexually transmitted infections and emphasizing the importance of contraceptives.
2. Prevention of Abuse and Violence: SexEd educates individuals about sexual abuse and violence, teaching strategies to prevent such occurrences.
3. Promotion of Equality: SexEd promotes awareness of gender equality and works to challenge stereotypes associated with gender roles.
4. Acceptance of Diversity: Comprehensive sex education raises awareness of diverse sexual orientations and gender identities, combating prejudice and promoting acceptance.

Schools often fall short of their social mandate when it comes to sex education, leaving adolescents to educate themselves through personal experiences or online media, risking misinformation. A comprehensive approach, incorporating various aspects of sexuality, is essential for fostering a healthy and open-minded attitude towards understanding sexuality, thereby contributing to individual and societal development.

To counter this, ERIK*A seeks to identify and bridge the gap between curriculum and practices in lessons. We set off with a key objective to provide Bavarian schools with a comprehensive handout, highlighting the essentials for appropriate and adequate sex education for pupils.



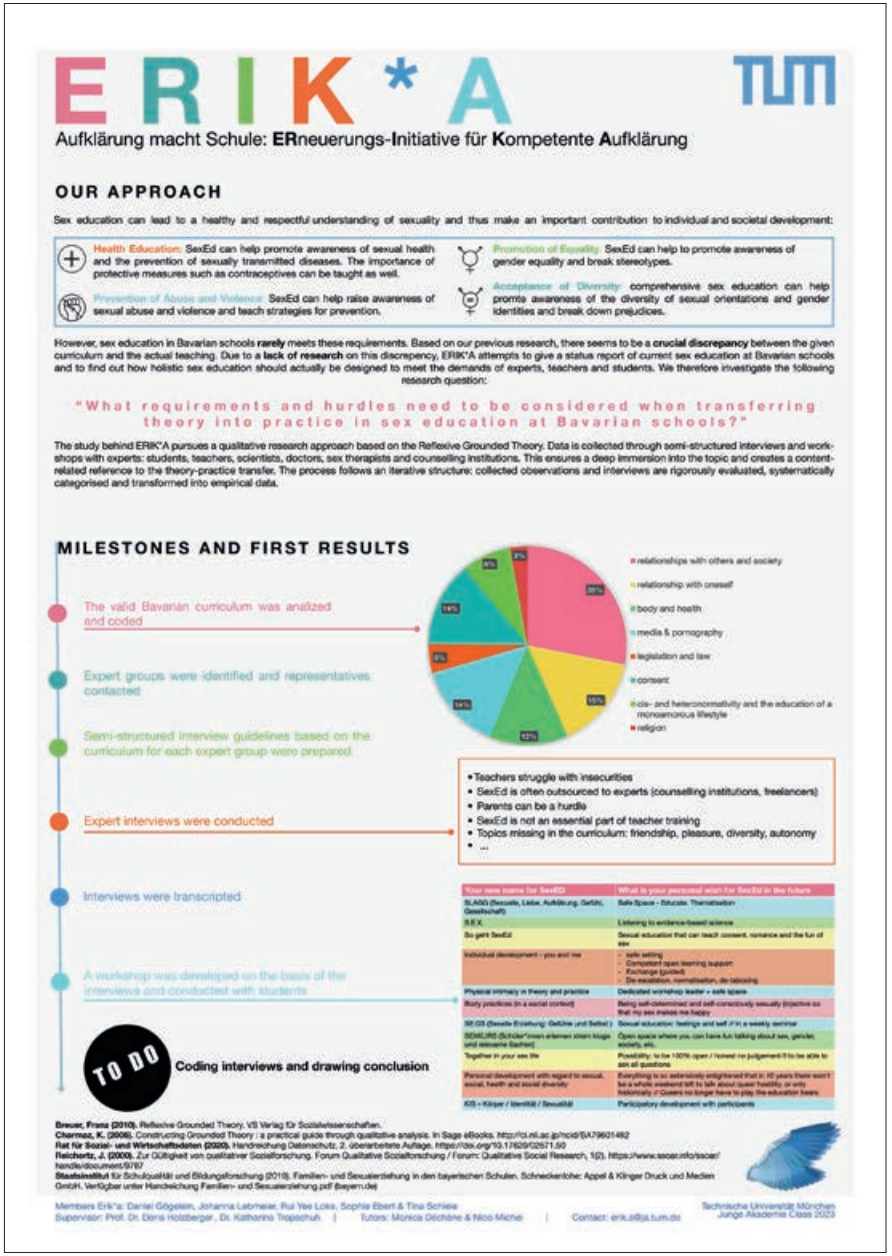
POSTER 2:

A thorough examination of the literature highlights a significant dearth in research regarding the discrepancy between the prescribed curriculum and actual classroom teachings. This discovery fuels our drive to provide a comprehensive status report on sex education in Bavarian schools and to explore how holistic sex education could be achieved to better meet the needs of experts, teachers, and students. Our central research question to address is: What are the demands and hurdles in the theory-practice transfer in sex education at Bavarian schools?

To tackle this question, we've adopted the Reflexive Grounded Theory Approach, developing theories directly from the data we gather. This ensures that our conclusions are firmly grounded in the evidence we've collected.

Data collection is primarily through semi-structured interviews, where interviewees have the freedom to elaborate in depth on their views. Structured questions tailored to their expertise guide the conversation. We've reached out to a diverse array of professionals for these interviews, including therapists, doctors, freelancers, NGOs, scientists, students, and teachers.

Throughout the interviews, we continually assess the clarity and conciseness of our guiding questions, allowing for adjustments if necessary. Concurrent with the ongoing interviews, we transcribe each interview word-for-word to ensure accuracy and preserve every detail for analysis.



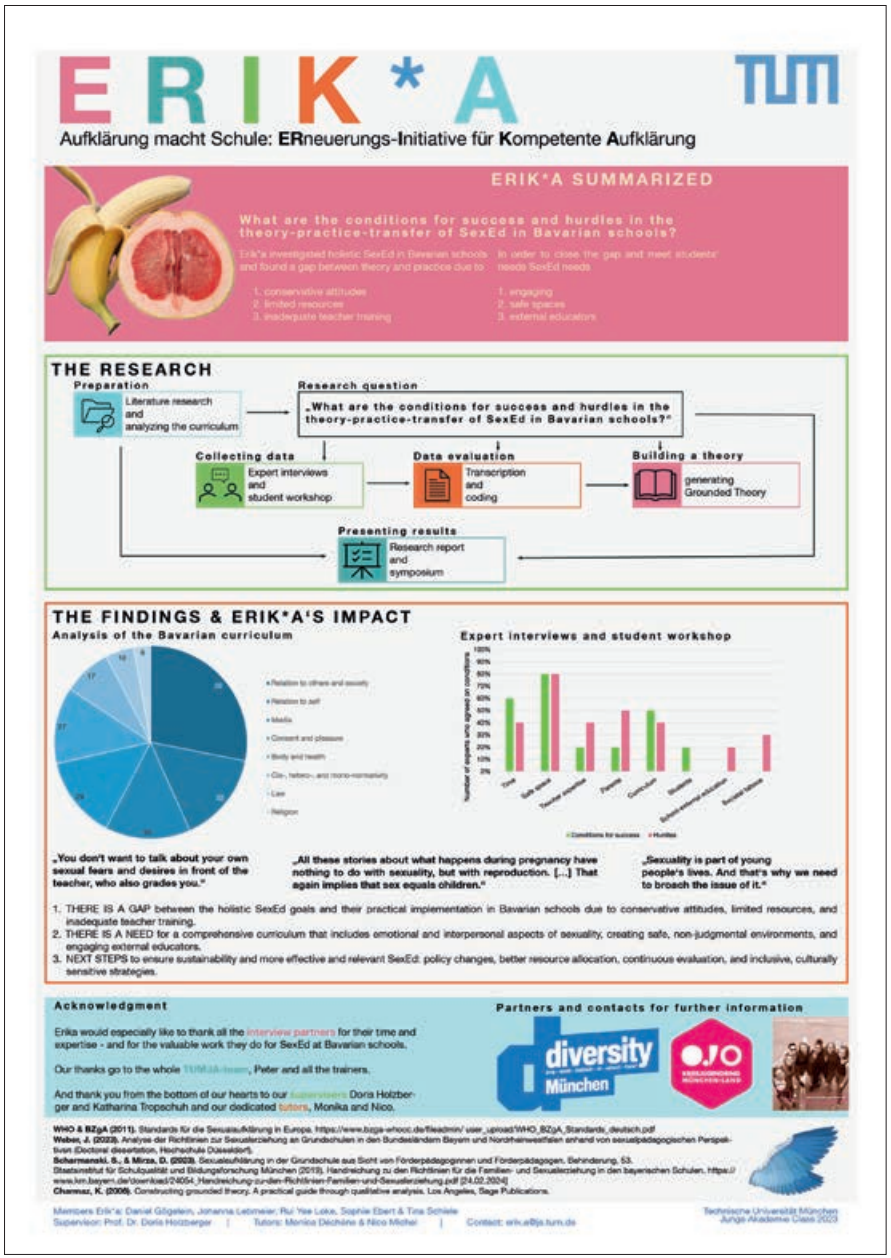
POSTER 3:

Following the completion of expert interviews, we made a comprehensive analysis of all transcriptions using an open, axial, and selective coding approach.

In this process, we closely examined text segments and categorized them by assigning codes to selected sections. Additionally, a workshop conducted during a weekend seminar provided valuable field observations, with field notes and a research protocol aiding in data classification.

From there, we identified relationships between the codes, linking axial categories together to create core categories that outline the key perspectives of holistic sex education in schools.

The key findings are compiled into a thorough status report, exploring the requirements and hurdles involved in translating theory into practice in sex education at Bavarian schools. Moreover, this report puts forward a theory on the optimal design of holistic sex education programs.

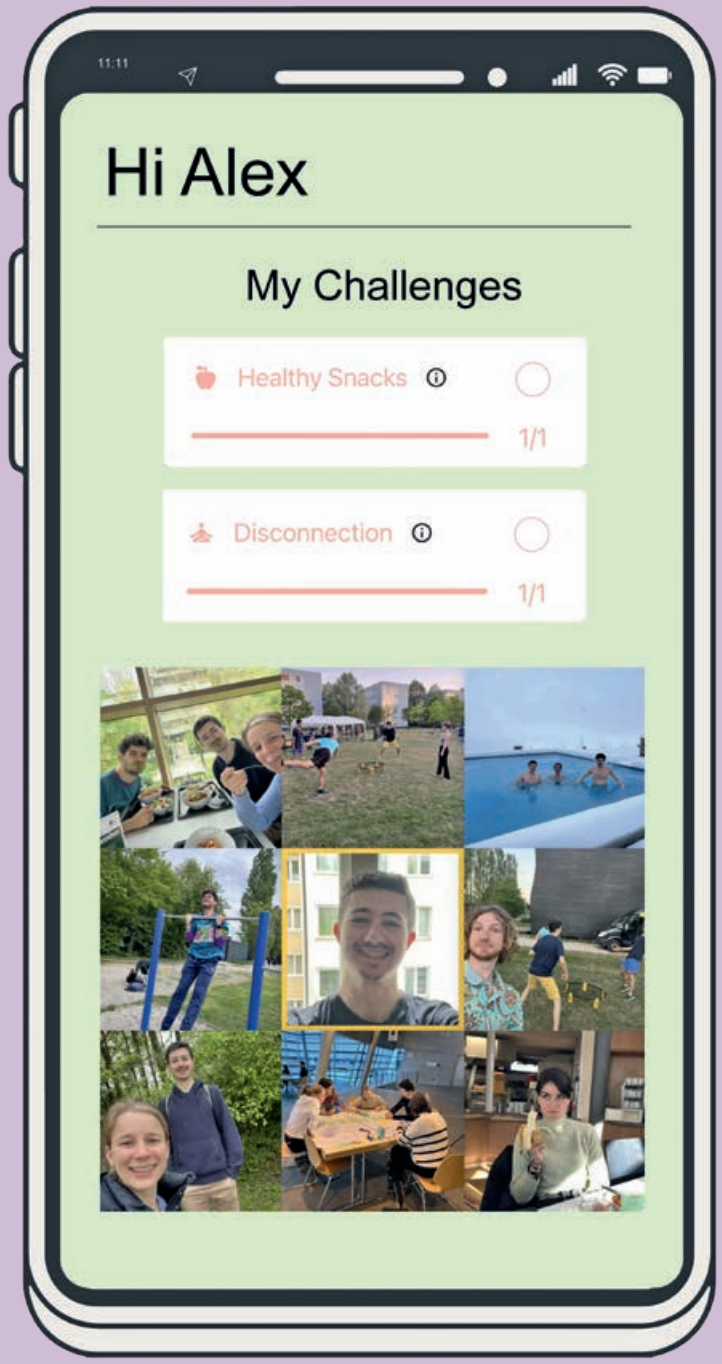


POSTER 4:

After completing our data analysis and evaluation, we synthesized the results and placed them within a broader societal context. Our primary goal was to identify the conditions for success and the hurdles in the theory-practice transfer of sex education in Bavarian schools. To explain our complex mixed-methods approach, we detailed our thorough procedures within a research life cycle figure.

We highlighted key findings from the diverse Bavarian curriculum, which extends beyond male and female anatomy and includes relationships, self-awareness, consent, and pleasure. Our research revealed a significant gap between the objectives of sex education and the current state of teacher training. Furthermore, there is a pressing need for a more comprehensive (implementation of the) curriculum. We outlined the necessary next steps to achieve a more sustainable and effective SexEd program in Bavaria. These steps include enhancing teacher training and curriculum development to better align with the goals of sex education.

In conclusion, we extend our heartfelt thanks to all participants in our interviews and workshops, and to every member of TUMJA, especially our tutors and supervisors, for their support and collaboration. We encourage everyone to sexucate themselves because we need more sexperts, not just in schools but in life in general!


11:11
Hi Alex
My Challenges
Healthy Snacks
1/1
Disconnection
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Research Report **Healthy Habits**

Why do we struggle so much to get rid of “bad habits” and at the same time build up “healthy habits”? What does healthy even mean? In today’s society, trying to find the right things to do can be overwhelming, and focusing on all of them is almost impossible. Our goal was to make building up “healthy habits” be fun and easy. In our project, we were focusing on daily challenges tackling different kinds of health: Physical and mental health, as well as nutrition. In order to gather concrete feedback, we built our own social media application in which users can set and complete daily challenges while sharing their achievements with friends and family through photos.

Team	Raluca-Ana-Maria Barna Moritz Friedemann Sandra Gross Helene Jung Camila Loaiza Santos Alexandra Cara Marquardt Flavio Principato Magalie Ross
Tutors	Jan Kochanowski Leonard Schmitt
Supervisors	Prof. Dr. Florian Röhrbein Prof. Dr. Volker Nürnberg

Preface by the Supervisors

Prof. Dr. Volker Nürnberg and Prof. Dr. Florian Röhrbein

As a supervisor, I have supported the “healthy habits” project with great pleasure, interest and passion. After all, it is dedicated to one of the biggest problems in our healthcare system: lifestyle diseases. As an expert in the Joint Federal Committee at the Ministry of Health, I am particularly involved with digital innovations. In principle, the healthy habits approach is very important for standard medical care! Challenges, gamification and low-threshold digital approaches are the right way to get “couch potatoes” moving. The goal is always an individual and sustainable change in behavior.

I would like to thank all the students for their extraordinary commitment and hope that they will remain committed to the idea of a healthy lifestyle; I look forward to staying in touch beyond the project.

Habits are automatized cognitive processes for decision-making. Within a particular context a stimulus automatically generates an impulse towards action, based on learned stimulus-context-response associations. This implicit type of processing information immediately yields a result while relying on minimal computational resources.

While healthy and not so healthy habits have been extensively researched in the fields of psychology, cognition, and neuroscience, they have yet to be systematically investigated in computer science! Data volumes are expanding at an exponential rate, and there is often a requirement for this data to be processed in real-time like in robotic systems. Against this backdrop, principles of habitual cognition present a promising alternative to resource-intensive planning algorithms, not only for humans but also for machines.

These thoughts go well beyond the scope of the current project I had the pleasure to supervise and I very much enjoyed being once more part of TUMJA. I wish everyone in my team a lot of healthy habits!

Supervisor insights

Prof. Dr. Volker Nürnberg

What is your research interest or motivation for science?
I would like to improve health promotion in all settings (at work, university, neighborhood, etc.) with innovations.

What was your best TUMJA moment?
I was able to invite the students to an event/congress in Mainz and talk to them all personally in depth.

What does mentoring the team mean for your own research?
The students think out of the box, are digital natives and represent social trends, which makes the collaboration mutually exciting

What special experience from your studies/career would you like to share with the scholars?
Careers are no longer linear, but disruptive. They are less predictable than they used to be.

How did your work as a supervisor influence you individually?
I try to move more in terms of the project. But I don't always succeed...

Supervisor insights

Prof. Dr. Florian Röhrbein

What is your research interest?
To me neurorobotics is an extremely fascinating field of research since it is at the intersection of neuroscience, AI and robotics. In my group at Chemnitz University of Technology we are trying to transfer insights about how our brain controls our body to artefacts like cognitive systems or robots. The many disciplines involved make this quite challenging but it is also fun!

What special experience from your career would you like to share with the scholars?
My career path was anything but straight. Moving from academia to industry, founding deep-tech start-ups, working for a corporate and eventually getting a professorship was quite some zigzag but I would be happy to do it again in the same way.

Picture your healthy journey

The alarm goes off, 7 a.m., it´s Monday morning, a little gloomy outside as Paul rolls over to hit snooze for another 5 minutes of sleep. When he reaches for his phone, a notification pops up from his friend Lisa. “Hey Paul, don’t snooze. Remember our new challenges on BeHealthy?” Feeling a little called out, Paul smiles to himself, turns off his alarm and opens his new app BeHealthy. He ticks off his challenge “Going to bed and waking up at the same time each day.” The app prompts him to take a picture of his accomplishment. “How do I show that I got up early in a picture?” he asks himself. Paul walks up to the window and takes a selfie in front of the rising sun. His face in the photo is smiling. In the app’s feed, he sees a picture of Lisa, smiling in the camera with her kettlebell, having already completed her exercise challenge for the day. Glancing over at his watch, Paul realizes he has some time left before his first lecture, so he pulls out his yoga mat for a quick morning yoga flow. “That was easy,” Paul thinks to himself, smiling as he ticks off his second challenge of the day.

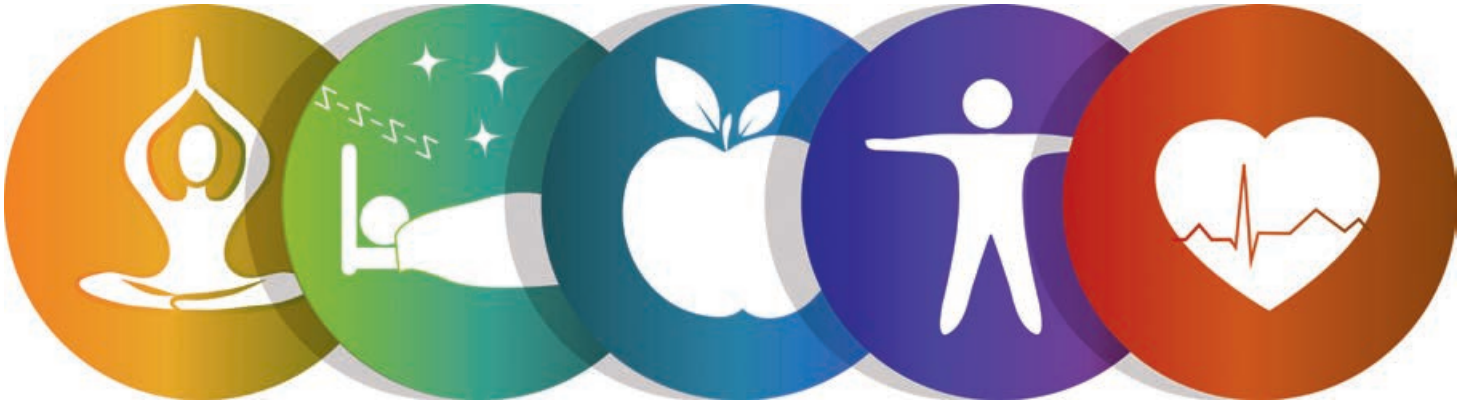
He leaves his house. Outside, his friend Tim is waiting for him. “Hey Tim. What a cool morning picture you posted! It will look great in our mosaic.” Both interested in maintaining good sleep hygiene, they created a BeHealthy mosaic together as an additional motivation. With every challenge one of them completes, the photo they take is added to the mosaic, so they are building it together. At the end of the year, the two have already made the plan to print out the whole mosaic as a poster and hang it on their wall.

BeHealthy is an app that was designed to help people build and maintain healthy habits in a fun way, together with their friends. It was developed as part of a student research project at the Technical University of Munich, interested in the healthy potential of social media. Everyone knows of the chaotic phenomenon of viral videos and internet trends, which can reach a large number of people. “Seeing your friend cook baked feta pasta might inspire you to cook the dish yourself,” says BeHealthy team member Helene Jung. Next to all the widely discussed and known harmful consequences, social media also helps people to gain knowledge of topics they would otherwise never have thought about, to develop social skills and to become an active member of society through creating and sharing content. However, one of the main critical points about social media are the hours wasted on procrastination with the help of social media apps, especially seen in young adults. (“The Effects of social media on College Students,” Q. Wang, W. Chen and Y. Liang, 2011). Considering this, the creators of BeHealthy wondered if there is a way to use social media´s positive effects and use them to cancel out its negative ones. With their project, the student team aims to answer the question of whether the key features of social media can be used to help people build healthy habits. Therefore, they designed an app, especially targeted at, but not restricted to, young adults and college students, that helps you to build healthy habits together with your friends. In the app, these healthy habits are represented by little challenges that the user can complete daily. These can be chosen and planned individually. Users set themselves a weekly goal and whenever a user completes a challenge like “Turn off your electrical devices 30 minutes before sleep,” they share a picture with their close friends, depicting their completion of the challenge. Coming up with a creative picture for the challenge is fun and makes the habit-building process less monotonous since

every picture is unique. Not only do you get to see your friends' healthy actions, there is also a way to keep track of your progress. Users can choose to build a mosaic together, an ever-growing collage of little challenge photos, to boost motivation and visualize their healthy journey.

"We decided to limit the communication between users to only one channel: Sharing photos. Our goal is not to create another application that people spend a lot of time on. After all, extensive social media usage is a common undesirable habit," says App developer Moritz Friedemann. With the absence of a chat feature, push notifications or a discovery page, the time that can be spent on the app is limited. Once users have posted their healthy picture and have seen the ones of their friends, they´re done and can carry on with their day feeling healthy and accomplished.

Paul now realizes it's time to head to his first lecture of the day. He grabs his water bottle on the way out and takes the stairs instead of the elevator for a change, smiles at the camera, ticking off his stairmaster challenge already. After all, "it is important to take small steps and make success visible in order to implement healthy habits in your daily life," says Michael Omann, the CEO of Movevo.



Research Report – Healthy Habits

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1. Introduction

Building lasting habits takes on average 66 days until they become integrated into people's lives (Clear, 2020). Although New Year resolutions are a motivating factor in integrating various types of health-promoting habits into people's daily routines, keeping them long term can be very hard. Oftentimes, this happens due to a lack of motivation in working on each behavior until it becomes automatic. Furthermore, in contrast to most negative habits, most healthy habits will only be rewarded much later. An example of this could be working behavior: procrastinating will give the immediate reward of avoiding stress and effort. The good habit of accomplishing things immediately might however only be rewarded hours, weeks or even months later, depending on the respective work. (Rutledge, 2021)

When trying to establish healthy habits, people are faced with a lot of distractions such as jobs or social obligations. But social media has a tremendous impact on people's lives as well: In Germany alone, people spend on average 101 minutes, or more than 1.5 hours, on social media per day (Harms, 2024). When considering this significant amount of time, the following questions arise: What makes social media so addictive? and Can the interactive tools of social media be used for something good? This is where our project "Healthy Habits" comes in, as this analyzes the potential positive influence of photo sharing on the development of healthy habits among young adults.

In section 2 of this paper, we will therefore start by defining the term "healthy habits," followed by a review of previous studies that showed a positive effect of social media on eating behaviors by utilizing social media features. This includes the possibility of supporting each other as part of a larger community and being able to demonstrate a certain behavior (Hsu et al., 2018). Keeping these results in mind, we will investigate whether such effects can also be used to enhance habit formation. On the other hand, a lot of criticism exists regarding social media, as it has been shown to have negative effects on mental health among teenagers and young adults. Thus, although we are aiming to use the effects of social media, this

should not lead to users spending a large amount of time on an app or starting to compare each other with strangers, e.g. influencers, as this can have more negative than positive consequences (Braghieri et al., 2022, p.3689). Our central focus lies in investigating whether social media can be used in a certain way which can promote positive behavior changes and healthy habits formation.

1.1. Thesis Objective

Our main objective is to analyze whether social media, or more specifically the sharing of pictures with friends, can be utilized to motivate users in performing regular activities meant to build healthy habits. We want to overcome the problem of people losing motivation in changing long-term behavior patterns by finding alternative ways to receive small immediate rewards in terms of sharing their activities with friends.

The question that shall be answered in our analysis is to what extent taking photos and sharing them with friends can increase the frequency of performing healthy tasks and the likelihood of building a habit. We do this by conducting interviews with experts in the field, using surveys as part of a market research and in-app questionnaires to get an insight into people's behavior.

1.2. Target Audience

Our target group are young adults aged 18-34, mostly consisting of, but not restricted to, university students. Apart from surveys and interviews, part of the data collection happens through an app which can be downloaded and used by anyone owning a smartphone. In our research we will mainly focus on the data from university students in order to have more easily comparable results, as students within a similar age group tend to have a more similar daily structure and social media behavior. To ensure the separation of these subgroups, users will be asked upon registration to indicate whether they are a student or not. The same question will also be asked as part of the market research surveys and interviews in order to be able to link the data later on. The exact content of the survey as well as the interviews will be explained in detail in section 3.

2. Literature Review

In the following subsections we will give a background into previous research that forms a basis for our research. To understand the potential impact of social media on the formation of habits, we mainly clustered our literature review into previous applications of social media in the context of health on the one hand and experience with apps created to facilitate the formation of habits on the other.

A habit is defined as an act or behavior done regularly, usually without consciously having to think about it or remember it.[11] In the context of our research, the term “healthy habits” can be seen as a broad term surrounding habits in various categories. This includes both physical health, such as exercise and nutrition, and mental health.

2.1. Social Media Tools in a Health-Related Context

Within the area of habit formation and behavior change, diverse strategies have been explored to encourage positive behaviors among people. Smartphone apps have emerged as tools that support habit formation through event-based cues and implementation intentions (Stawarz, 2015). Within a broader economic context, the concept of working habits within a neoclassical growth model was introduced, revealing their impact on labor supply (Faria, 2004). An investigation in 2010 identified key factors influencing information technology (IT) habits, including prior IT use, satisfaction, and perceived importance (Lankton et al., 2010).

Delving into the role of habits in post-adoption switching of personal information technologies, a study in 2011 explored its influence on both intention and actual behavior. This research emphasized the significant role of online social network dependency in habit formation (Thadani, 2011). Simultaneously, the dual impact of social media on health behaviors was highlighted, acting as both an obstacle and a motivator (Vaterlaus, 2015). In examining social networking sites, a study in 2019 distinguished between habit and addiction, emphasizing the positive influence of habit on goal-congruent outcomes and the negative impact of addiction.

1 see https://dictionary.cambridge.org/dictionary/english/habit#google_vignette

Current research suggests that a comprehensive approach is vital for fostering positive behavior changes and cultivating healthy habits. This approach involves integrating various strategies, such as context-dependent repetition, intention-setting, and the reinforcement of self-efficacy. This perspective aligns with findings from Thadani (2011), Vaterlaus (2015), Seo (2019), and Liu (2011). While technology, including smartphone apps and online social networks, holds potential for shaping and reinforcing habits, it is crucial to exercise mindfulness to avoid the potential of challenges related to addiction, ensuring a balanced and mindful usage (Stawarz, 2015; Thadani, 2011).

2.2. The Role of Apps in Habit Formation

Existing research indicates that effective habit formation apps should prioritize event-based cues and the reinforcement of implementation intentions, rather than relying solely on reminders and self-tracking (Stawarz, 2015; Wicaksono, 2019). However, it's important to note that these apps might inadvertently foster a dependency on continuous usage, potentially hindering the establishment of long-term habits (Renfree, 2016). In response to this concern, an alternative learning-based approach has been proposed, emphasizing the guidance of users through small daily changes (Vainio, 2014). This approach offers the potential for users to cultivate sustainable habits without developing excessive reliance on the app.

Research within the field of behavioral change suggests that integrating small daily challenges can effectively drive positive behavior changes and contribute to the development of healthy habits. Strategies proposed to initiate new behaviors, support context-dependent repetition, and facilitate automaticity, as recognized in previous work (Lally, 2013), have proven valuable in the establishment of new habits. Moreover, the role of short-term incentives in developing habits in children indicates that behavioral changes may persist even after the removal of incentives, as highlighted by Loewenstein's findings (2016). In the context of IT habits and habit formation, the significance of adherence, particularly within the realm of e-health interventions, is emphasized (Karppinen, 2018). A comprehensive approach shows the importance of simultaneously breaking existing unhealthy habits while promoting and establishing healthy ones for sustained and beneficial long-term results (Wood, 2016).

User satisfaction, habit persistence, perceived usefulness, and the intention to continue usage are key influencers of the sustained use of habit formation apps (Hsiao, 2016). Moreover, a proposed framework for designing apps that support lasting behavioral changes underscores key elements, including personalization, easy data recording, interactive reviewing, and subtle interventions (Stroulia, 2013). Some examples of subtle interventions within this framework include personalized reminders based on individual habits, gentle nudges to encourage positive behaviors, or prompts for self-reflection. These subtle strategies aim to influence user behavior without causing disruption, fostering a more seamless integration of the app into daily routines.

3. Methodology

3.1. Market Research, Surveys

To gain deeper insights into the needs of our target group, we set up a survey consisting of six items asking about (1) the willingness to build new habits, (2) the willingness to use an app for habit formation, (3) the willingness to specifically use a photo-sharing app for the purpose, (4) whether the participant sees social engagement as helpful in establishing new habits and (5) which features of an app would enhance habit formation. Furthermore, the participants had the option to give additional information on age, occupation and gender, to help us get a clearer vision of our target group. The survey was conducted via Google Sheets and promoted via mouth to mouth, the project´s instagram page (@behealthy_tum), the TUMJA alumni mailing list, the StudiNews newsletter and via the TUMJA network in general.

3.2. Expert Interviews

To gain a deeper understanding of habit formation and especially habit formation in the context of an app, we set up interviews with experts from the field of behavioral psychology and health science, focusing on experts whose research focuses on habit formation. The interview questions specifically ask about tips to improve the habit building process and how to support people through it, the experts' experience with digital tools in habit formation, and possible challenges that arise when using digital solutions.

3.3. Development of the "BeHealthy" App

To examine our hypothesis and explore the impact of social media mechanisms on habit formation, we developed a smartphone ap-

plication designed precisely for this objective. To achieve it, the app needed to serve as a platform offering two primary functions: the ability to choose and complete regular challenges, and the possibility of sharing photos with friends. Additionally, it needed to gather the relevant data for our subsequent analysis. We called the app "BeHealthy" to reference the goal of the app for its users. In the following paragraphs, we describe the development of the app and the thoughts that went into design decisions regarding its features.

3.3.1. Challenge Mechanism

According to findings from our literature review, which strongly indicate that habit development relies on personally selected objectives (Gardner et al., 2014), BeHealthy users have the autonomy to select challenges and determine the frequency of their completion per week (referred to as "weekly goals") on their own.

They can choose from a set of 21 predefined challenges clustered into the following three categories:

1. Nutrition: This comprises challenges surrounding healthier, regional and more sustainable nutrition, for example, to eat only plant-based foods for one day.
2. Be active: This includes both activities of daily life, such as taking the bike instead of the car on the way to work, but also active exercises, such as going for a run. The exact scope of the challenge should be defined by the user depending on their fitness level.
3. Sleep & Mindfulness: This refers to any challenges related to mental health, sleep, structure, etc., e.g. writing down 3 things you are grateful for today.

To reduce the initial resistance people might have, the challenges are designed to be quickly and easily achievable throughout the day. Additionally, users are prompted not only to choose challenges but also to determine a weekly completion goal, allowing them to schedule when to undertake the challenges throughout the week. This goal can be modified according to the user's schedule and experience with the challenge. Furthermore, the progress for all challenges is reset every Monday at midnight in order to define a weekly rhythm for all users.

Upon completing a challenge, users can mark it as done within the app, advancing the progress bar by one step and opening the camera feature. While users have the option to skip this step if they prefer not to take a photo, they are encouraged to either capture a picture or upload one from their camera roll, which will then be shared with their friends on the app.

3.3.2. Social Aspect and Incentivization

While BeHealthy is a social medium in so far as it connects people interested in building healthy habits, we limited the communication through the app to only sharing photos. There is no chat feature or other communication channels in order to avoid giving an incentive to spend large amounts of time in the app. In their feed, users can see the photos of healthy challenges that their friends completed. These posts disappear after 24 hours.

BeHealthy allows users to collect their photos in "mosaics", on which they work together with friends or colleagues. A mosaic is a grid that users can fill step by step with their challenge-related photos. The idea behind this is to allow users to look back on their habit building journey and appreciate how far they have come, which is an important factor of motivation. Expanding the mosaic together further increases motivation of all contributing users. To avoid incentivizing users to spend a lot of time with the mosaics, it is not possible to rearrange the photos and their position can't be chosen either. The latest photos are always in the center to focus on the present accomplishments.

Other social media apps often use gamification to make their users spend more time in the application. Earning points, climbing up ranks or keeping a winning streak alive are all examples of strong incentives based on gamification (Sarbadhikari & Sood, 2018).

Since these features impact the user's motivation, they could be confounding variables when analyzing the effect of sharing photos. In order to isolate the effect and to avoid behaviors like posting a blank photo just to keep a winning streak alive, we decided to reduce the extent of these features to a minimum. With the same goal of isolating the effect of sharing pictures, we decided against sending users reminders to work on their challenges, even though this might further increase motivation.

3.3.3. Implementation

The app was programmed using the React Native Framework.[2] This JavaScript-based programming framework allowed us to develop an app for both IOS and Android simultaneously. By using this method, we were able to reach a larger target group without significantly increasing the development effort.

To further facilitate the development process, we used the open-source framework Expo,[3] which provides various tools for creating a development environment, building the App executable and submitting it to the App Store and Google Play Store.

Given the diverse data our app manages, including user accounts, challenges, and photos, a robust database connection is essential. To uphold user privacy and avoid reliance on servers hosted by tech companies like Google or Amazon, we integrate PocketBase,[4] an open-source backend service and open-source alternative to Google's Firebase. PocketBase provides a database structure compatible with React Native and includes features such as secure user authentication via passwords and usernames. Moreover, it grants us the flexibility to host the database on a server of our choice. To ensure responsible and secure data management, all data is stored on a server at the Leibniz-Rechenzentrum (LRZ) in Munich.

3.3.4. Data Collection in the App and Key Metrics

The BeHealthy app gathers various types of data throughout its usage.

Upon initial registration, users are prompted to complete a one-time initial survey aimed at establishing a baseline of their current habits and behavioral patterns. Additionally, ongoing follow-up surveys are conducted weekly throughout the study to monitor the progression of habit formation over time, utilizing the SRBAI (Self-reported-behavioral automaticity index), a tool endorsed by the American Psychological Association and widely employed in numerous studies.

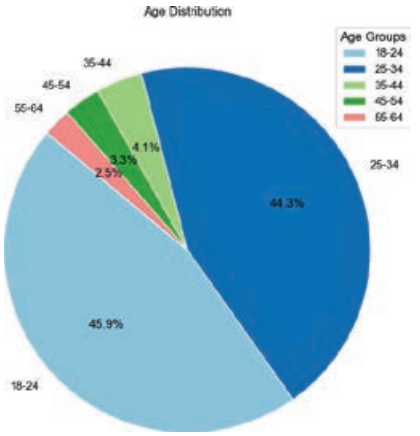
Furthermore, in addition to survey responses, the correlation between achieving challenge goals and the frequency of photo uploads is monitored to investigate the hypothesis that sharing photos can positively influence habit formation.

Lastly, a demographic correlation analysis is conducted to explore potential associations between age, gender, and the observable effectiveness of habit formation.

4. Results and Discussion

The purpose of this analysis is to explore the tendencies of the target population regarding their openness to trying an app aimed at promoting healthy habits. The data was collected through a survey openly shared and filled out online by 122 participants.

The survey included participants from all age groups, as illustrated in the following pie chart. The majority of respondents were distributed across two primary age brackets: 18-24 years, constituting 45.9% of the sample, and 25-34 years, accounting for 44.3% of the participants.



2 see https://reactnative.dev/
3 see https://expo.dev/
4 see https://pocketbase.io/

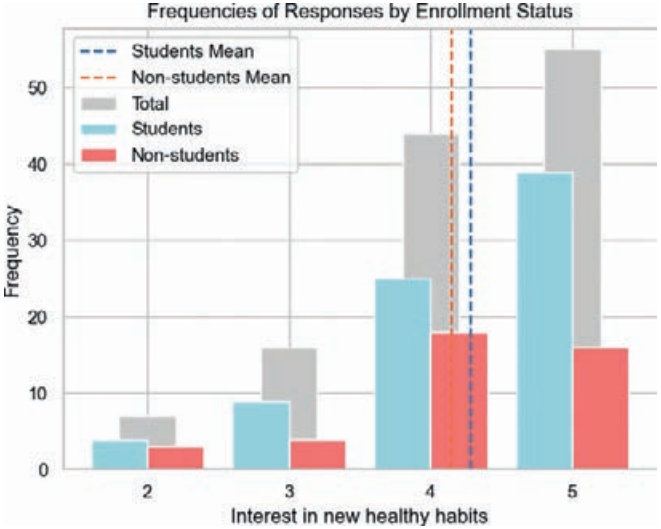
Consequently, the age distribution corresponds with the expected target group. Additionally, more than 65.3% of the participants are currently enrolled in a study program.

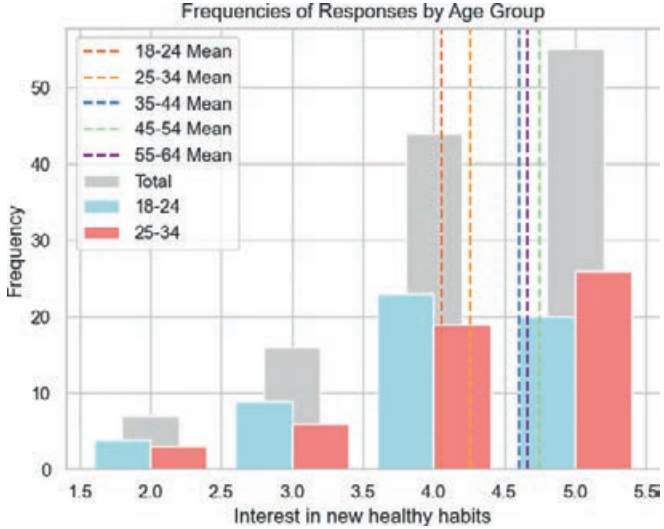
The survey experienced greater participation from the female demographic, with approximately 55.7% of respondents identifying as such.

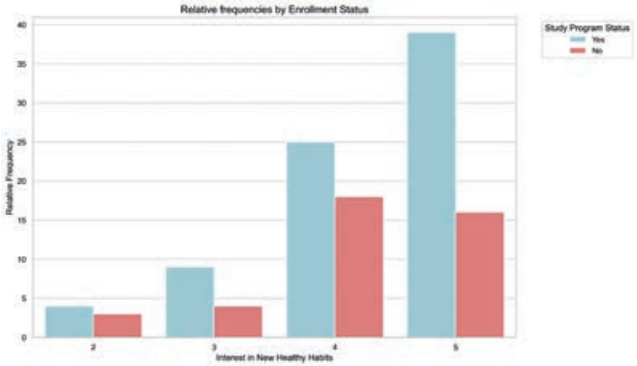
As the target population is represented by young students, the following analysis will use the enrollment status and age group as a term of comparison with age being clustered into the following three groups: 18-24, 25-34, and 35 and older.

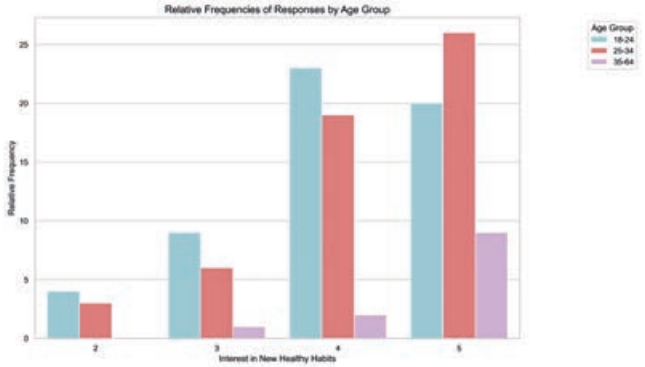
4.1. Interest in healthy habits formation

Regarding the general interest in the formation of healthy habits, the responses show a large interest across the largest proportion of participants: on a scale of 1 to 5, 81.5% selected 4 or 5 for the question as to how much they would like to implement healthy habits into their routine. Greater interest in new habits formation was expressed by students compared to non-student participants. Interestingly, participants aged 25 and older expressed a higher interest in habit formation than young adults.







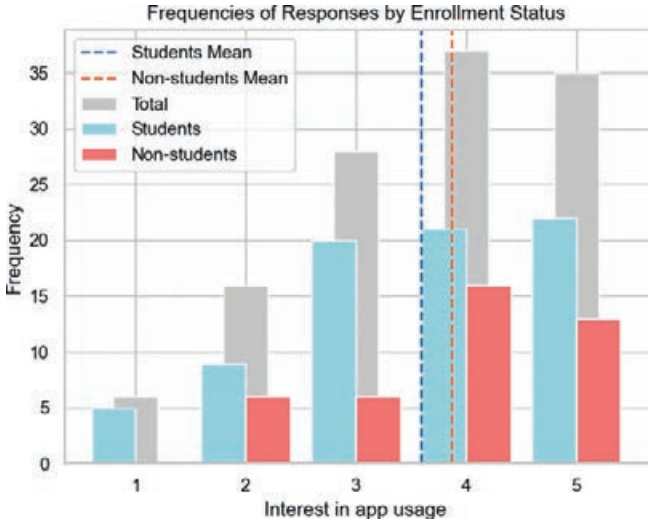


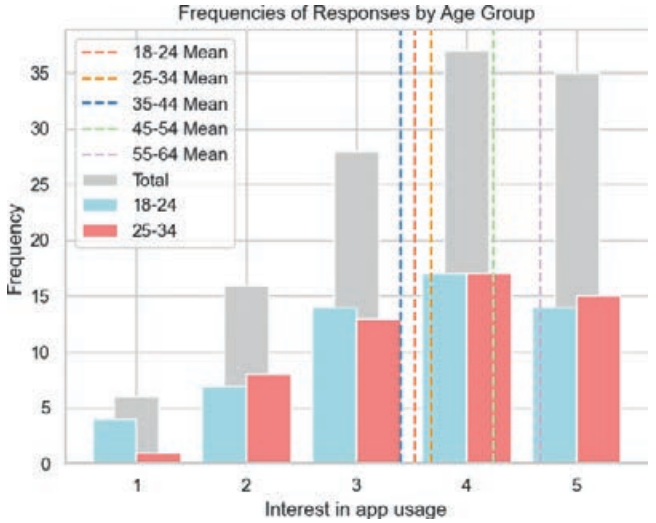
4.2. Using an app for building new healthy habits

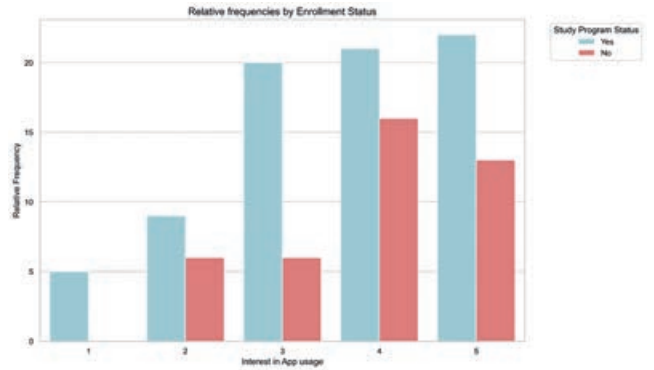
The second question explored participants' willingness to use a mobile application for forming new habits. While the results are not as straightforward as in the first question, 59.6% of participants either agreed or strongly agreed with using an app (30.33% chose “4”, 28.69% chose “5”). This suggests an openness to utilizing technology as a tool for cultivating healthy habits, with however a considerable percentage expressing uncertainty or reluctance.

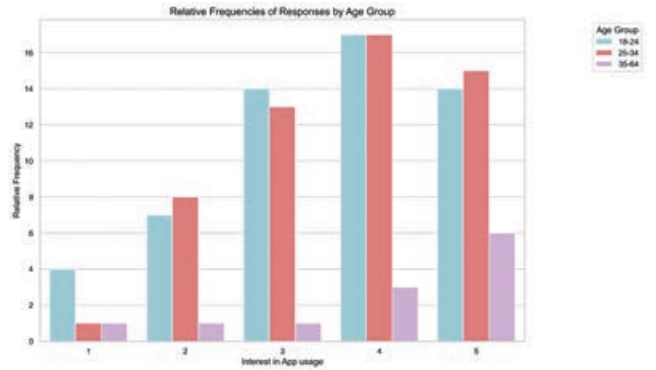
Non-students show a slightly higher inclination toward app usage compared to students, with minor differences across age groups. Furthermore, higher age groups tend to show a slightly higher interest in utilizing an app than participants from the younger groups. Nevertheless, both students and the 18-24 age group still express a strong openness to adopting an app for habit-building.

The results emphasize the variation in willingness to adopt an app-based approach, influenced by age and student status. It is important to analyze results both within and between different groups. This approach of differentiating between both student status and age group allows for a comprehensive understanding of the varied perspectives and trends existing within each group and facilitates a







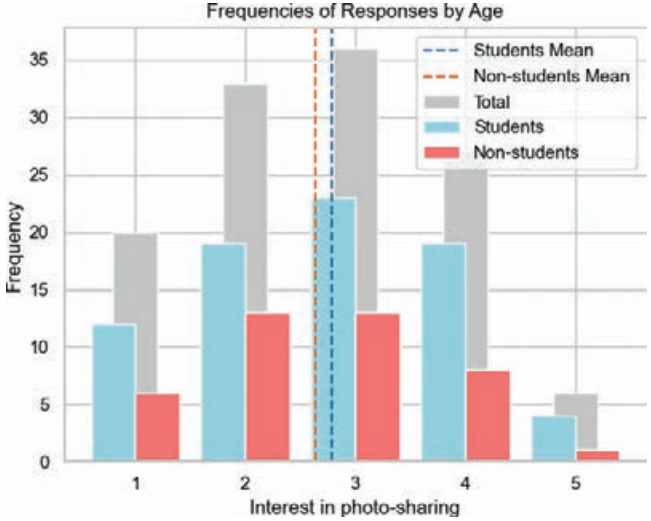


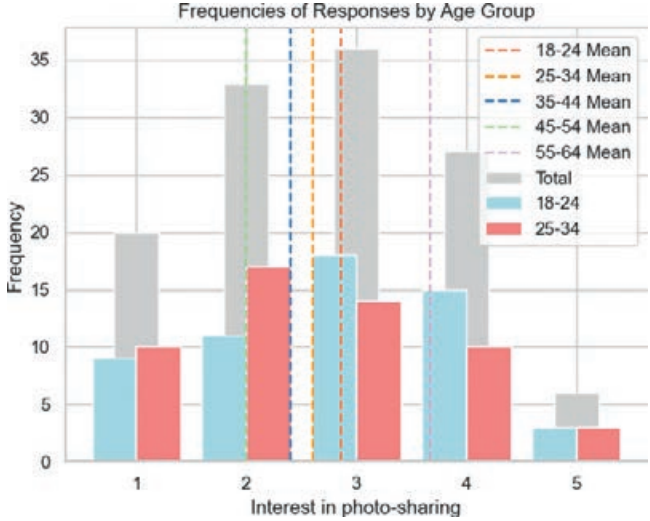
comparison of how different demographic segments respond to the questions. Moreover, the observed variation in responses, whether examining between or within age groups and student status, may result from differences in the age distribution of participants, particularly with a substantial number falling between 18 to 24 and 25 to 34, contributing to increased diversity in opinions.

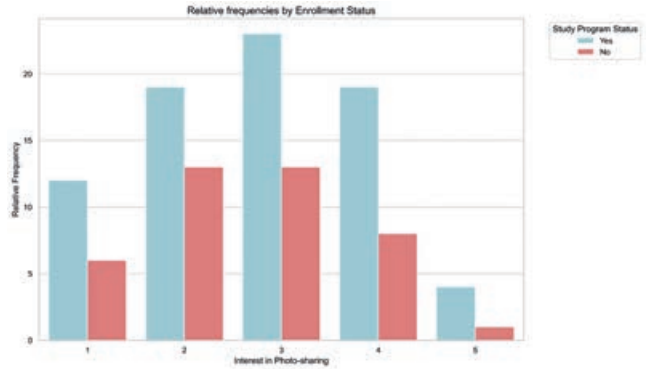
4.3. Photo-sharing app

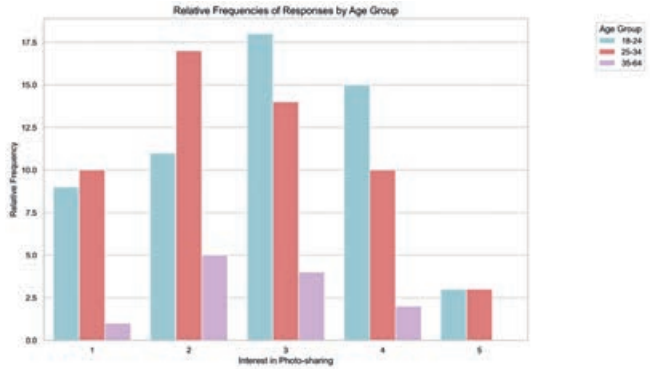
The third question asked participants whether they believe a photo-sharing app could be helpful in developing healthy habits. About 30.6% of respondents believed it could be somewhat useful (score 3). 27.05% expressed reservations (score 2). The distribution indicates a varied view on the potential effectiveness of photo-sharing apps, with the majority falling in the middle of the scale.

Participants' perceptions of a photo-sharing app as a tool for building healthy habits revealed interesting trends. In the 18-24 age group, both students and non-students saw potential in a photo-sharing app, with non-students leaning towards higher ratings. The 25-34 age group, especially non-students, expressed a favorable view of the app's usage, while students showed a more diverse response.









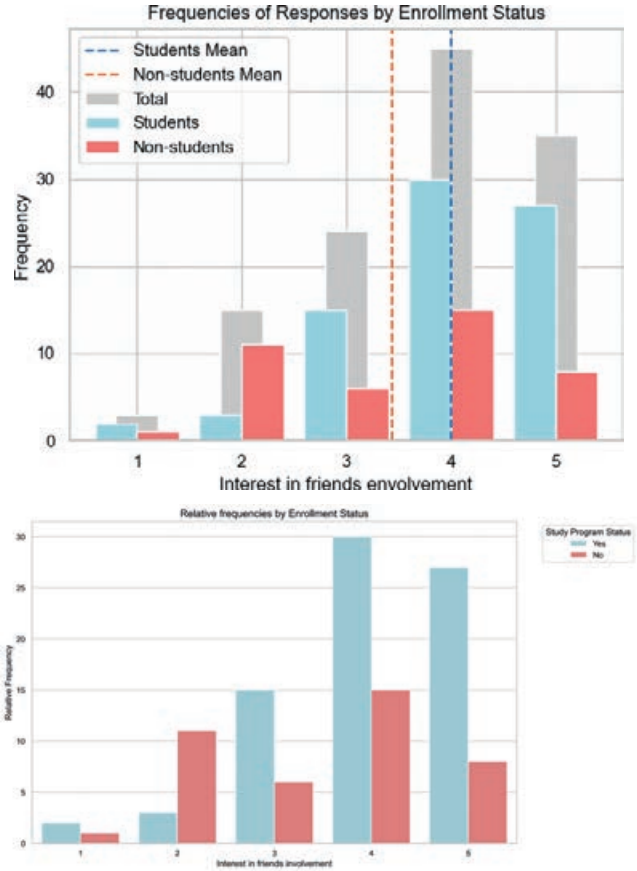
4.4. Friends' involvement

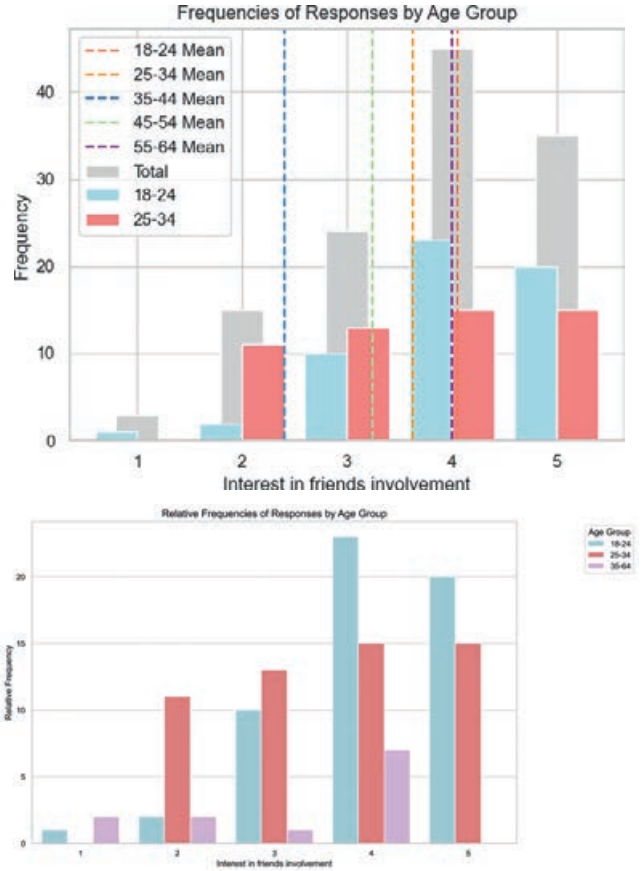
37.1% of participants believed involving friends in one's health routine positively impacts their ability to establish and maintain healthy habits (score 4), and 28.69% expressed an even stronger agreement (score 5). This suggests a recognition of the motivational and supportive role that friends can play in fostering healthier lifestyles.

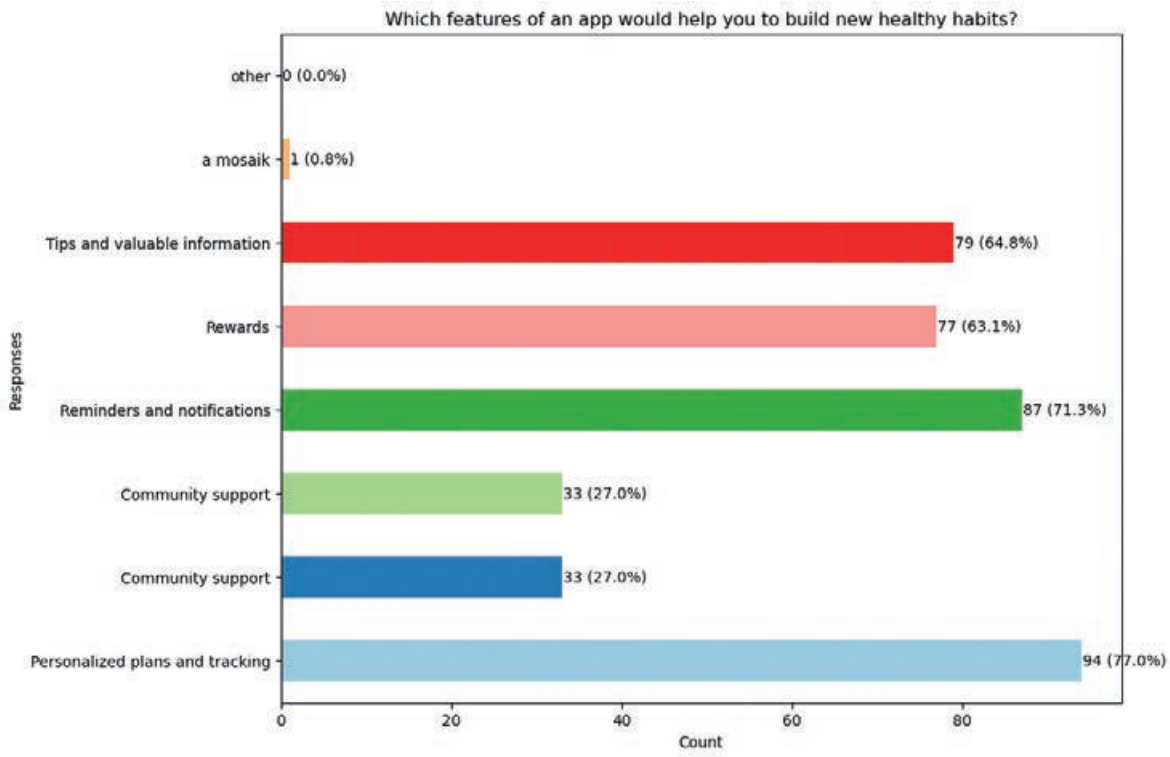
Participants aged 18-24 and 25-34 expressed a relatively positive view, with a significant percentage favoring ratings 3 and 4. Upon delving into the distribution of responses between enrolled students and non-students, it becomes evident that students generally show a higher level of agreement. Conversely, when we break down the responses by age group, it can be observed that younger students tend to have a lower average agreement. However, this could be attributed to the larger number of responses from this age group, potentially leading to greater variance compared to older participants.

4.5. Relevant features

In the graph below, it's clear that individuals prioritize certain features for fostering new healthy habits. Personalized plans and tracking hold the highest importance, with 77.0% agreement, followed by reminders and notifications at 71.3%, and tips and valuable information at 64.8%. Understanding these preferences is crucial for adding future features to the app.







4.6. Expert Feedback

A total number of three experts on habit formation were interviewed and their findings and feedback will be summarized in this section. Those experts were Bastian Schmidtbleicher of MOOVE GmbH, Christian Hoffmann of lebensfreude gesundheitsmanagement and Michael Omann, founder of MOVEVO. They were interviewed regarding four main questions:

1. What mechanisms/incentives can be helpful regarding habit formation in general?
2. Do you have experience with digital solutions in the area of habit formation (or if not, why and do you believe a digital approach can be helpful)?
3. Do you know of similar projects or approaches like ours? If so, what were challenges for you and what worked well?
4. After a demonstration of the app: what can be improved, especially regarding the habit building process?

4.6.1 Positive Feedback

Our interview partners liked the idea of photos to visualize the results, giving users the possibility to look back on their healthy journey. This reflection and reminder of the effort one has already put into forming the habit is beneficial to maintaining one's motivation. The design of the challenges also received positive feedback. They represent small tasks which are easy to implement, which is essential for the habit formation process. The user's resistance to taking a step towards their goal must be kept as small as possible and there must be intermediate goals like completing a ring of photos in one's mosaic in our app.

4.6.2 Suggestions

In order to answer our research question about sharing photos, we needed to isolate their effect. One strong confounding variable we decided to eliminate are notifications which remind the user of

completing their challenge, which would have a significant effect on motivation. From our interview partners, we got the feedback that these reminders are very beneficial for the success of the individual habit formation process. Another suggestion was to let the user define their personal goal and motivation in the beginning and to frequently remind them of it visually. Additionally, we were advised to further motivate users to complete challenges together to connect their habit to social contact.

5. Conclusion

To conclude, our findings show that there is an interest in an app that helps users to integrate new healthy habits easily into their daily routine. Furthermore, a substantial number of surveyed people consider that involving friends in their habit building process can enhance habit formation, which is especially interesting for us with the background of challenge mechanism and app design.

Even though the time the project required exceeded our expectations and plans, good things have come from it. Apart from being a learning experience for all team members, the questions and design decisions we discussed in the context of the app are important for the future of social media, particularly for designing these in a benevolent and healthy way.

Instead of simply talking about a potential healthy social media, we made it easy for users to provide valuable concrete feedback by proposing a concrete application with all the design decisions made by us. This feedback and the lessons learned in the process, may be the biggest positive result of the project. The team is highly motivated to continue the research with the vision of a social media that helps people build healthy habits in the near future.

Once the app has been running with a substantial number of users, we are aiming to collect data from the app and conduct interviews with users as described above for our future research. This research will be used to get not only qualitative, but also quantitative data on actual users in order to better understand the effects of social media and photo sharing on habit formation.

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Self-reflection

“You’re making a mistake.“ When we, Team Healthy Habits, presented our idea to develop an app to help people build habits, not one, not two, but most of the TUMJA’s trainer team advised us to rethink our decision. Past project teams had already tried it and had to face major difficulties or reduce their scope later in the project. We took this feedback very seriously and decided to pursue our idea nonetheless. We wanted to actively help people, not only analyze and ponder what a good approach would look like. While, as time would tell, the warning proved to be valid, we are still very glad that we made this decision. All of us have learned a lot about teamwork, habit building, marketing, questioning one’s whole project, and setting deadlines to get things done (as strongly encouraged by the trainers). Every team member can look back on the project and say, “I contributed something meaningful to this project,” and in our 20 months of being scholarship holders, we created something tangible that could help people.

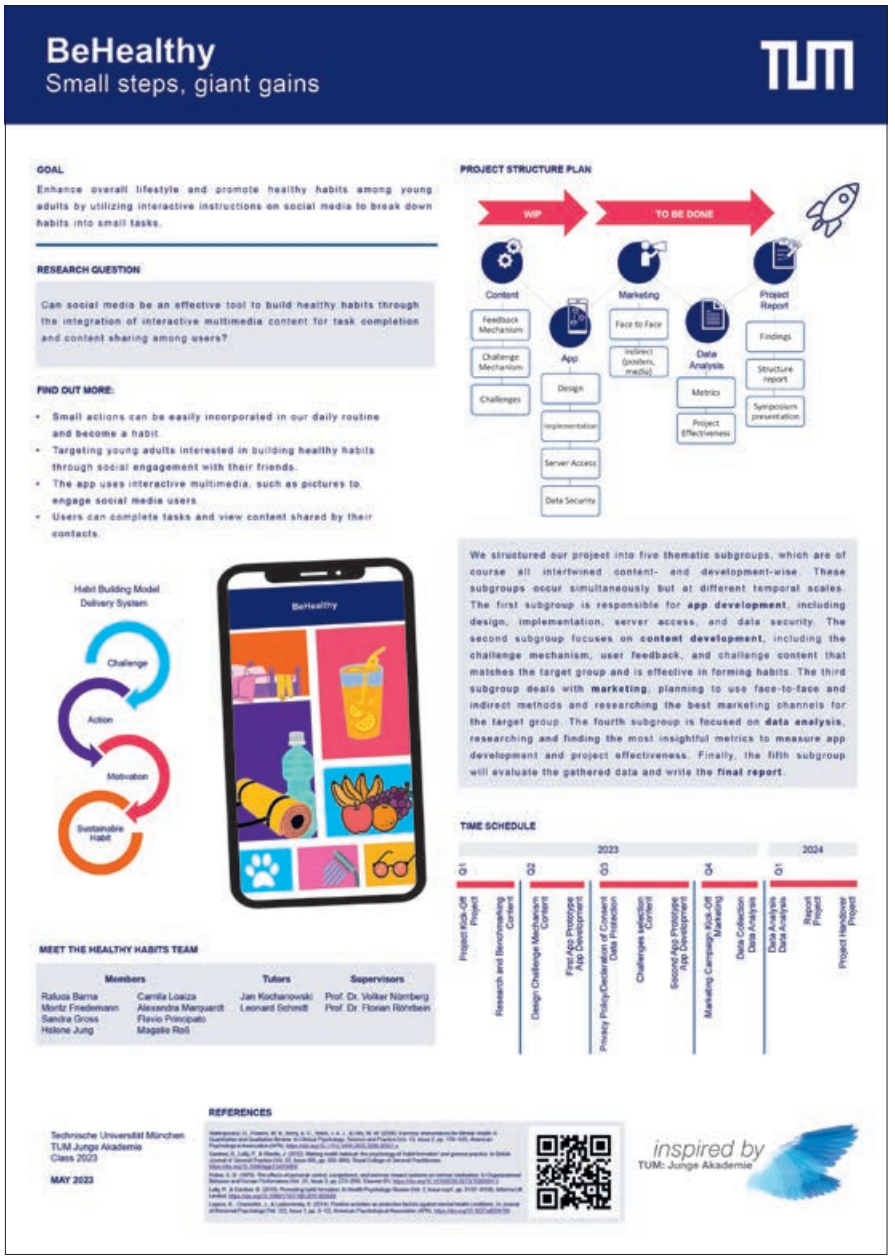
One of the biggest strengths of our team was the good mood and spirit since the beginning. After the kickoff weekend, the team consisted of only four members and in the following weeks it doubled in size. Even though those new team members hadn’t been there since the very start, they were integrated well and didn’t feel left out. In the beginning of the 20 months period, we came up with some traditions that we kept up until the end. One example has to do with the hybrid nature of our team meetings. Between exchange semesters, internships, and other obligations, there was no point in the 20 months when every member was in the same place. That’s why we did our weekly meetings in a hybrid format. All those who could make it in person, met at the TUMJA office and also joined a zoom meeting with those who were abroad. Organizing these meetings wasn’t always easy, since at one point, we had to unite Canadian, European and South-East Asian time zones.

At the end of every meeting, we took a meeting photo (there are over 30 of them). It feels good to look back on the progress of the project and the changes all the team members went through during their time at TUMJA. To give a glimpse, we decided to put a mosaic of these meeting photos in this report. It is in the spirit of our project, as the app enables every user to do the same, build a mosaic of their habit-building progress, and look back on what they have accomplished and how they might have changed in the process. We also measured (more or less scientifically by the angle of the members’ thumbs up) how the mood and productivity were in each meeting. The resulting graph of mood and productivity scores was quite interesting, too, as it clearly displays phases of lower productivity that the team experienced. These phases are part of every big project and are often related to longer distances between teammates or problems faced in the project. In our case, they led to a significantly delayed launch of the BeHealthy app, especially since we underestimated some of the difficulties in developing a whole app from scratch. Among many others, many bugs would surface during user tests, and we had to let users try BeHealthy as beta testers because we couldn’t get an independent ethics committee’s appraisal in time to make the app available in all stores.

As we have put so much thought, passion, and resources into the project, it stings a little bit to end it in a somewhat unfinished state, with marketing measures waiting to be employed and the potential to help people. That’s why a group of team members is still convinced by the idea and motivated to keep the project going after the time at TUMJA. So stay tuned for what’s to come…

Your Team Healthy Habits

Acknowledgments
This project would not have come nearly as far as it has without our wonderful tutors. Leonard and Jan not only brought a fun and familiar vibe into the team but contributed many good ideas. They also attended most weekly team meetings and weekend seminars. Throughout the project they felt more like two additional team mates than like external tutors. We want to thank our supervisors for their feedback and the valuable contacts we have made through them. We're especially grateful to Prof. Nürnberg for inviting us to the Top Arbeitgeber Kongress TAK in Mainz, where we got to see him and Dirk Nowitzki speak and meet experts in corporate health management like Christian Hoffmann to interview about our project. Big thanks to everyone who tried out and used our app. The concrete feedback was very useful in fixing many little mistakes and evaluating whether this app actually helps people. Last but not least, this kind of project is made possible by TUMJA and their unique positive ambiance that motivates a whole team to do a project together for 20 months. During the seminars and office discussions, we learned a lot from the inspired people that TUMJA brings together. We're proud to be a part of it.



POSTER 1:

Our project started out with the aim of finding effective ways to integrate healthy habits into our daily routine. We thought of small challenges that should be fun to do and give people concrete tasks for the day which are rather easy to solve and can actively be ticked off once completed. During our literature research we found many papers and books that all agree on small steps being imperative for habit formation. Yet, we realized that while there are so many initiatives on how to build healthy habits one step at a time, most people fail to keep working on them before these behaviors even become habits. So, we thought: what tools are already in people's everyday life that we could utilize to support habit formation. The first thing that came to our minds was social media. And while we found that social media can have both a motivating and an addictive factor, we also found that it has already shown itself to be helpful in other contexts such as eating disorders. Using this knowledge, we finally decided to utilize the positive aspects of social media to motivate people in their habit-building journey and to incorporate a social factor by building an app.

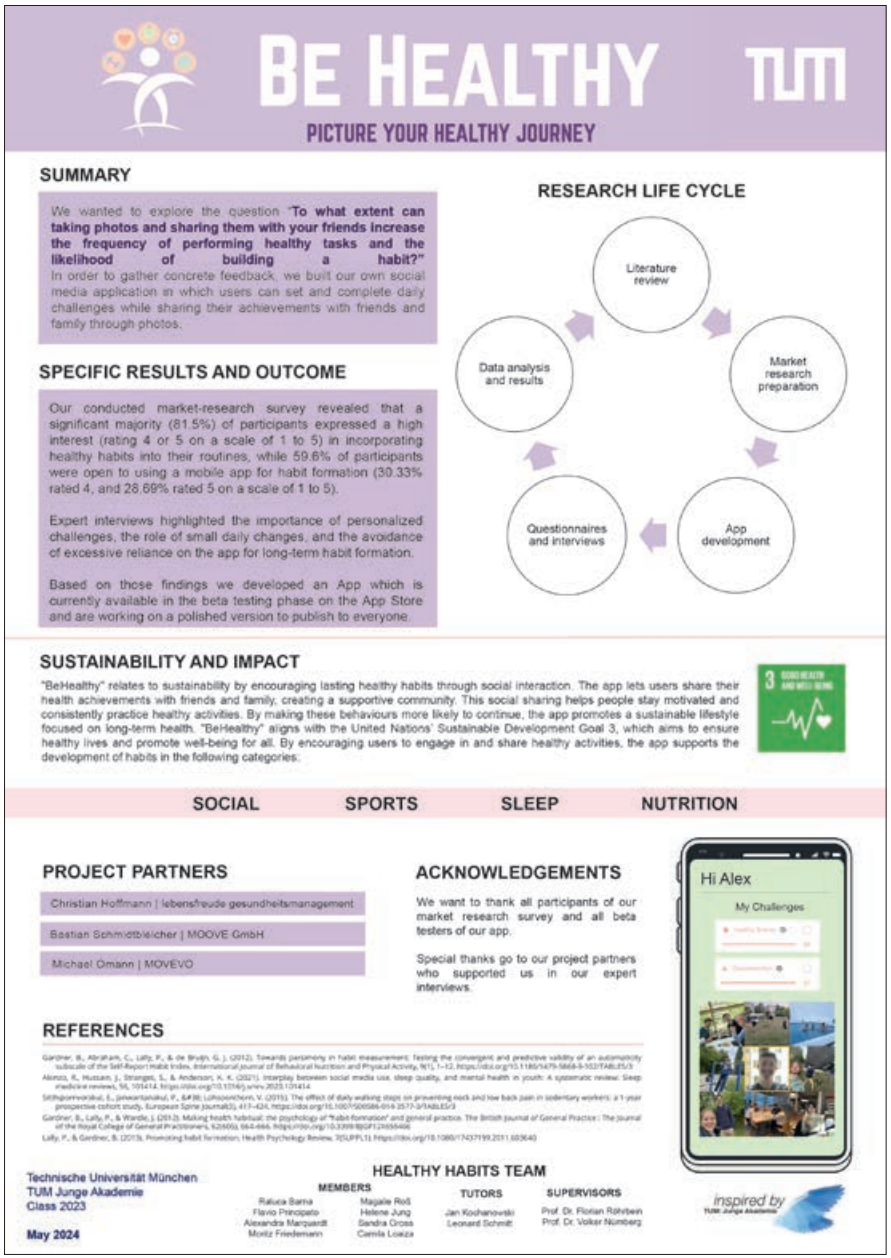
During the following months, we split our group into the following three subgroups to work on the project: App development, Content/Challenge Mechanism and Marketing.

POSTER 2:

To answer our question to what extent sharing photos of performing healthy tasks can increase the frequency of performing these tasks and the likelihood of building a habit, we incorporated several scientific methods. The basis for our research lay within the app itself since we did not build it only in response to our initial research, but also as a tool for collecting the necessary data for our main research later. While continuously collecting data on challenge completion and pictures shared, we planned also to integrate bi-weekly surveys in the app. The purpose of the app usage data is to set these in relation as part of a regression in order to get an understanding of whether users who utilize the social media aspect of the app more often also tend to perform better. Since this, however, only indicates the frequencies of use and no conclusions on habit formation can be drawn, the survey - which includes questions from the SRBAI ("Self reported behavioral automaticity index") by the APA – has the goal of showing progress on the habit formation. Finally, to supplement our data, we decided also to conduct interviews with app users to add a qualitative approach in terms of self-reflection.

POSTER 3:

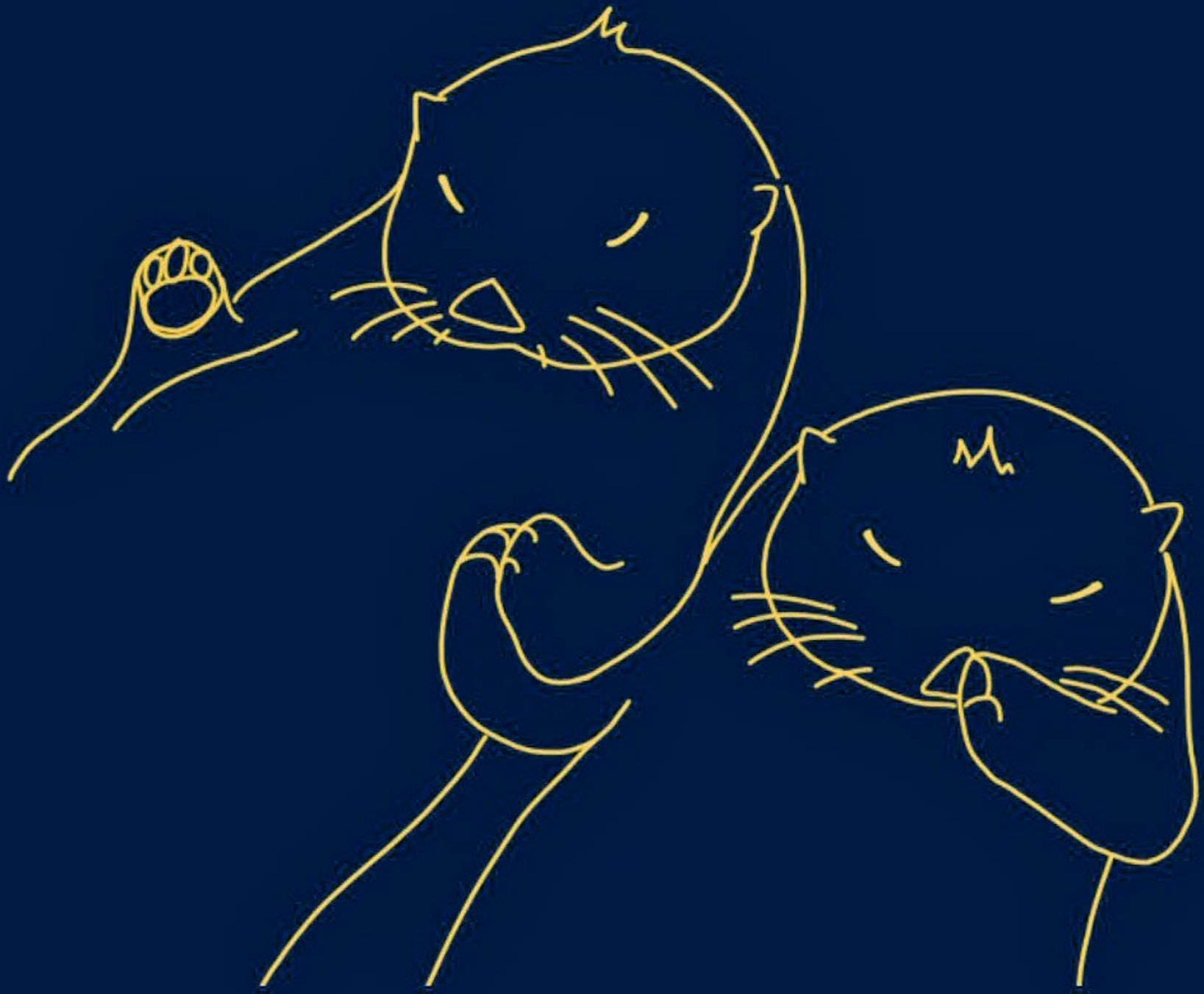
While our development team was working on programming the app, they were in close contact with the content team. The latter came up with the process on how users should be guided through the app, at which stages surveys should be introduced and how the challenge mechanism should be set up, including the respective challenges for each of the three categories: Nutrition, Activity, and Sleep & Mindfulness. Meanwhile, the marketing team prepared the app launch by presenting the project at student fairs, designing flyers, posters and branded pens and creating an instagram account to increase visibility. On top of the bi-weekly surveys, we also decided to include an initial survey to assess the initial state of our users lifestyle which may be repeated at a later stage to make a comparative analysis between the “before” and “after” state. The survey included questions such as their average daily sleeping time, their preferred way of commuting, their primary diet, etc.



POSTER 4:

Because of delays in the app launch (for which there were many reasons), we had to find alternative ways for our initial data collection in the final stage of our project. We decided to conduct market research surveys with potential app users to get early feedback and ideas on what aspects might help users build healthy habits. The participants of the survey ranged across all age groups, though with a large proportion of students since these are also the target group for the final app. Furthermore, we held interviews with experts in the field of health and habit formation, including Christian Hoffmann (Health Manager Lebensfreude), Michael Omann (CEO Movevo), and Bastian Schmidtbleicher (Manager Moove). With their help we gained deeper insights into our topic and received valuable feedback for the app to help us further improve it.

Our app "BeHealthy" is currently available in the Beta version on the app store where we are currently testing it with a rather small number of users before it is officially launched. Moving forward, we would like to continue our research through the utilization of the app to add onto our existing findings with more quantitative data.



Research Report **Somnoactive**

As poor sleep is a major problem in today's fast-paced modern society and among students, team Somnoactive intended to promote healthier sleep and to improve the overall wellbeing. Therefore, we created and easy-to-implement daily routine which combines a short exercise with scientifically proven measures to enhance student's sleep quality. Furthermore, we investigated how incentives for active reflection and feedback on already achieved progresses impacts the motivation to follow the routine. To get an additional insight into cross-cultural aspects, we not only conducted the study at TUM but also at Kwame Nkrumah University of Science and Technology in Kumasi/Ghana.

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Tutors	Genoveva Müller Elisa Rodepeter
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Preface by the Supervisors

Prof. Dr. Philipp Reiss and Prof. Dr. Manuel Spitschan

Poor sleep is a major problem in today's fast-paced, 24-hour society, reducing productivity, affecting social relationships and causing mental and physical health problems. The goal of the Somnoactive team was to create an effective routine that promotes regular and improved sleep, and thus overall wellbeing, and that can be easily integrated into daily life.

To achieve this goal, the team implemented a study with university students, accompanied by interventions of short, daily exercise routines, a sleep diary, and suggestions for improving sleep hygiene while measuring the sleep-wake cycle using wrist-worn actiwatches. With their study, they raised awareness for this important topic and found that the multi-component intervention has a significant positive impact on subjects suffering from insomnia. The team also conducted a second study in collaboration with Kwame Nkrumah University of Science and Technology (KNUST) in Ghana, a flagship partner university of the Technical University of Munich, investigating cultural differences.

As supervisors, we were thoroughly impressed by the high level of motivation within the team and the self-directed management of the entire project – from concept to analysis. As the topic was new to most of the Somnoactive team, their accomplishments are all the more impressive and noteworthy.

Supervisor insights
Prof. Dr. Philipp Reiss

It was an insightful experience to see how the team developed their idea and realized it within a very short time besides their studies. The team showed great commitment by bringing together expertise from various backgrounds and produced a novel method to investigate and improve sleep hygiene – a topic that is highly relevant to us all.

What is your research interest or motivation for science?
As a professor of lunar and planetary exploration, my goal is to develop and expand our knowledge and capabilities in space science and exploration, with a focus on volatiles and resources on planetary bodies. Besides research, my priority is the education of our students, providing them with the best possible opportunities and supervision to acquire and develop their skills and prepare for a future career.

What special experience from your studies/career would you like to share with the scholars?
During my studies I was always actively seeking practical experience by participating in various projects, internships, and student groups. In a small team, we even developed and launched a microgravity experiment on a sounding rocket, which was an outstanding learning experience I still treasure today. The university environment offers a variety of such opportunities, including TUMJA, and I encourage our students to explore these and go beyond the common boundaries of the study program.

Supervisor insights
Prof. Dr. Manuel Spitschan

It was great to see the team flourish and take full ownership of the project. The topic – using a simple and scalable intervention to empower people to optimize their sleep hygiene – is right at the core of my research group's interest.

What was your best TUMJA moment?
Seeing the team reach out to potential partners at KNUST in Ghana, a flagship partner university of TUM was great. The team demonstrated the feasibility of this novel arm of their project and acquired further funding for it. As a circadian neuroscientist and sleep researcher, the 'global' approach to research is key, and seeing the Somnoactive team have this view toward the horizon, and leaping towards it, was invigorating.

What does mentoring the team mean for your own research?
Mentoring the Somnoactive team brought home the value of an interdisciplinary team approaching a joint problem of high importance not only to science but also to society. As a scientist, professor research group leader, it can sometimes be easy to work only within one's own scientific silo. Seeing a student team take an interdisciplinary approach was exciting and extremely rewarding. ■

Did you sleep well last night? Most likely not!

Improving students' sleep in Ghana and Germany

As Prof. Atinuke Adebanji opens the door to her office, she wears a bright smile and a patterned dress of vivid orange and purple colors. The dress is self-designed; she learned how to sew when she was younger and still uses that skill to design her own clothes nowadays. Five of us are visiting Kumasi for one week and asked her for an interview. Prof. Adebanji is a Professor at the Department of Statistics & Actuarial Science at the Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi, Ghana, where she holds her lectures and coordinates the Laboratory for Interdisciplinary Statistical Analysis (LISA). Besides her work as a professor, she is a founding member of WiSTEMGh (Women in STEM, Ghana). This initiative offers mentoring workshops and summer schools to senior high school girls and young women, to inspire and support them to become senior scientists and technologists. Prof. Adebanji had her battles to fight, being a woman in a male-dominated field. Growing up in Nigeria, she knew from a young age that she had two passions – books and teaching, but the journey to research would take some twists and turns. Having left secular work in accounting to be a stay-at-home mother for about 7 years, she entered academia in 2003 as an Assistant lecturer at the Department of Mathematics, University of Agriculture, Abeokuta, Nigeria. In 2009, she was the acting head of the newly created department of Statistics when she became aware that KNUST was looking for a lecturer to introduce a Statistics program at the university, so she left her former university and moved to Kumasi to focus on her academic career – even though she was the only woman in the Maths department at that time.

Fourteen years later, she is hosting us at her university for our sleep-related study. The topic of 'sleep' is becoming more and more famous and awareness about its importance for physical and mental health is increasing. Still, the student population tends to suffer strongly from insomnia, bad sleep quality and low sleep duration. The number of young adults with diagnosed sleeping disorders is rising. Many students do not get the recommended 7-9 hours of sleep per night, especially not during exam periods. This can lead to several mental and physical problems and a reduction in academic performance. Although research on the topic has increased significantly over the last two decades, effective solutions to this problem still need to be found. We aimed to provide a low-threshold routine that improves the participants' sleep efficiently without taking up too much time every day or changing the students' day-to-day life too radically.

To do that, we designed a 30-day routine. During the intervention, the participants receive a video every morning, which includes an easy and short workout to stimulate the cardiovascular system and a scientifically proven suggestion on healthy sleep hygiene practices. We previously carried out the study in Munich and are now looking for participants at KNUST. After both studies, we would like to compare sleep habits in Ghana and Germany, keeping in mind the different cultural and climatic conditions.

We are not the first research group of TUM that is visiting KNUST. The strategic partnership between the two universities started in 2018, after several collaborative projects. Prof. Adebanji herself isn't very involved in the partnership, but started working with professors at TUM, mainly Prof. Müller from the Maths Department and Prof. Tellier in Genetics, about two years ago. A few of her graduate students participated in the TUM.Africa Talent program, an exchange program for doctoral candidates, and, therefore, stayed in Munich for three months. At the closing event of this program, two of us first met Emmanuel Owireda, a participant of TUM.Africa and Assistant Lecturer at KNUST. He later helped to organize and conduct the study in Kumasi and initiated the first contact between Prof. Adebanji and us. When she first heard of the project, she was happy and excited to host us in Kumasi, especially because she hoped to encourage contact between us and KNUST students. She envisioned a gathering of both groups, to give the KNUST students the opportunity to ask questions about life and studies in Germany. Unfortunately, such a gathering did not take place during the week we stayed in Kumasi due to a tight schedule. Hopefully, future teams can take this opportunity.

We did, however, visit several lectures to advertise our project and to look for participants for the study. In the end, we were able to enlist 54 students, the same number of participants as we had in Munich. All students were introduced to the topic and the study procedure and were equipped with a sleep tracker. The sleep tracker is an essential part of the study and measures the activity of the person who wears it throughout the night. With this information, it is possible to determine the participant‘s pattern of sleep phases and draw conclusions about changes.

After the interview, we present some gifts from Munich, a Beer Making Kit and gingerbread hearts, to thank Prof. Adebanji, Emmanuel and all the other responsible people for their help and hospitality throughout the past week. We definitely enjoyed our stay in Kumasi and encourage other teams to organize a similar exchange themselves. Hopefully, we were able to strengthen the bond between TUM and KNUST and help students in both universities to sleep better in the future.

Our Top Ten sleep facts:

- Start your day outdoors! Exposure to natural light can assist in waking up and prevent afternoon crashes.
- Create a relaxing bedtime routine tailored to your preferences, like reading or listening to soothing music, and limit screen time to avoid disruptive blue light.
- Incorporate a cold shower into your morning routine to feel more energized throughout the morning.
- Limit caffeine intake within the first hour or two of waking up and avoid it before bedtime to ensure a restful night's sleep.
- If you're having trouble falling asleep, get out of bed and do a calming activity until you feel drowsy rather than staying awake in bed.
- Exercise in the morning to enhance alertness and synchronize your body's internal clock.
- Experiencing orgasm, no matter how it's achieved, can help with falling asleep.
- Determine your chronotype (morning lark, hummingbird or night owl) to understand your natural sleep tendencies and, if possible, adjust your schedule accordingly.
- Resist the urge to hit snooze to avoid disrupting your sleep cycle.
- If you need a nap, aim for a short duration of 10-20 minutes to prevent disrupting your nighttime sleep

The Impact of Self-reflection and Feedback in an Intervention on Sleep Habit Improvement

The importance of sleep for health and well-being is well known, yet third of all adults in the US report getting less than the recommended amount of sleep. Here, we investigate the impact of feedback and incentives for active self-reflection on drop-out rates in a 30-day intervention for sleep habit improvement. Furthermore, the impact of the intervention on the participant's sleep routine and quality is studied. After the study an overall reduction of BIS scores is observed for participants completing the study. A significant improvement is noted in participants identified as "insomniacs" at the beginning of the study, providing some evidence that the multi-component intervention including sleep education, physical exercise, and relaxation techniques, has a positive impact on subjects suffering from insomnia. Study groups receiving incentives for active reflection by filling out a sleep diary, or additionally receiving feedback on sleep improvements, showed a higher motivation for study continuation and therefore a lower drop-out rate.

Background:
The importance of sleep for health and well-being is well known to the general public. However, poor sleep and insomnia remain prevalent issues worldwide. A reason for this prevalence could be that adhering to routines aimed at treating symptoms is difficult. Therefore, we studied the effect of feedback and incentives for self-reflection on the completion rate of a 30-day multi-component intervention, including sleep education, physical exercise, and relaxation techniques. Also, the effect of the intervention on the participant's insomnia and sleep hygiene knowledge was studied. A comparison between participants in Germany and Ghana was made.

Methods:
Healthy students (n = 56, age range 18-30) were randomized to three study groups, one watching only videos during the intervention, one watching videos and filling out a daily questionnaire, and a third one watching videos, filling out a daily questionnaire, and getting weekly individual feedback. The Bergen Insomnia Scale was used to assess insomnia symptoms before and after the study, while a Sleep Hygiene Knowledge questionnaire based on sleep myths and evidence-based sleep hygiene recommendations was used to assess improvement of knowledge before and after the study.

Results:
After the study an overall reduction of BIS scores is observed for participants completing the study. A significant improvement (5 points compared to pre-intervention) is noted in participants identified as "insomniacs" at the beginning of the study, providing some evidence that the multi-component intervention including sleep education, physical exercise, and relaxation techniques, has a positive impact on subjects suffering from insomnia. Study groups receiving incentives for active reflection by filling out a sleep diary, or additionally receiving feedback on sleep improvements, showed a higher motivation for study continuation and therefore a lower drop-out rate.

1 Introduction

Understanding of the importance of sleep for well-being, i.e., physical and mental health, as well as cognitive and physical capabilities, is well established [1, 2, 3]. Although the significance of sleep is widely recognized and acknowledged by the general public, it is often disregarded that maintaining a consistent sleep schedule can help in regulating the circadian rhythm and enhancing overall sleep quality [4]. Acting as an internal clock, the circadian rhythm regulates hormone production and the body's metabolism, as well as people's sleep [5]. A disturbance or lack of sleep is therefore associated with a disruption of the internal clock, potentially leading to adverse health effects such as obesity [6], hormonal imbalances [7], mental health problems [8], and learning and memory difficulties [9] (see e.g. [10] for a review).

Poor and inconsistent sleep is not a niche problem but affects large swathes of society, with one-third of Americans reporting getting less than the recommended amount of sleep [11], one out of ten Europeans suffering from chronic insomnia [12] and also 7.5% of

adults in low- and middle-income countries reporting sleep problems [13]. More alarmingly, the prevalence is increasing [14], highlighting the importance of addressing this issue on a societal level. Within 20 years, the prevalence of sleep problems in low-income countries is expected to almost double, from 150 million in 2010 to 260 million in 2030 [15].

There are major social reasons for sleep deprivation and sleeping patterns that diverge from the 24-hour light-dark cycle. The phenomenon of shorter sleep during work weeks has been coined as "social jetlag," and with the rising availability of instant media and entertainment, this often leads to strong variations and disruptions in sleep patterns resulting in reduced sleep quality.

To tackle the adverse health and other negative effects [16] of poor and/or insufficient sleep and promote better sleeping quality, a simple but effective intervention, that can be used on a large scale without requiring any advanced tools, is desirable. Albakri, Drotos, and Meertens [17] reviewed existing intervention studies and classified them into eleven broad categories, namely: sleep education, behavioral change methods aimed at promoting awareness and active control of routines and stimuli, relaxation techniques, physical exercise, mind-body exercise that combine meditation with physical exercise, aromatherapy and or massage, environmental, psychotherapy, later school times, multicomponent, and others. The effectiveness of these interventions varies strongly among studies, with Lie Åslund et al. [18] reviewing six studies among school-age children and adolescents and finding an increase in total sleep time (TST) and sleep onset latency (SOL) in the intervention group during the studies. The positive effect on SOL remained in follow-up studies 4-8 weeks later. A review of interventions that included education on sleep hygiene behavior among undergraduate or graduate college students (18 years or older) found three studies reporting no significant difference on sleep quality ($P > 0.05$) and only one study reporting significant improvements ($P = 0.017$). Although the sample size of reviews is small, Albakri, Drotos, and Meertens [17] found promising improvements in TST and sleep quality for physical exercise interventions and some small positive impacts on sleep duration for sleep education interventions.

For a broad application in the general public, a multi-component intervention, including sleep education, physical exercise, and relaxation techniques, hold up to the aim of being simple in their implementation and requiring no additional tools. It should therefore serve as a good basis for a sleep improvement protocol.

Even though studies with similar methodologies reach different conclusions and overall impact appears low, there were no reviews indicating adverse effects. This indicates that the reason for no significant improvement in sleep duration and quality in certain studies might have been a consequence of how motivated and prepared the participants were to change their sleep habits, how relevant and important sleep was to them, and how the intervention was delivered and designed [19].

Therefore, an important aspect of a successful intervention is to make the program engaging – like Duolingo for language learning, for example.

Most importantly, an intervention should keep participants' intrinsic motivation high over a long time. To build a long-lasting habit, it takes around 66 days of repetition [20], while a lack of motivation and the appearance of boredom are major reasons why people stop routines beneficial to their health.

One of our aims is therefore to study how intrinsic motivation can affect the adherence to a sleep improvement routine. The developed 30-day program, designed around proven sleep hygiene measures to help students establish a better sleep routine, is outlined in detail in subsection 3.1. The students participating in our study all followed a 30-day program, whereby one group was encouraged to actively reflect on their sleep by filling out a daily questionnaire, the second group, on top of that, got weekly feedback on their progress, while a control group only followed the 30-day program without further reflection incentives or feedback.

2 Goals

The primary objective of the study was to investigate the conditions under which students maintain their motivation to participate in a 30-day intervention on sleep and physical activity. This research interest led to the formulation of the following research question:

Research Question: How do feedback and incentives for active reflection influence the motivation of participants to stay engaged and committed to a 30-day routine to improve their sleep quality?

Based on the research question, a hypothesis was developed:
Hypothesis: Participants who receive specific feedback on changes regarding their sleep during the 30-day program will be more motivated to continue with the intervention. Furthermore, we expect that existing incentives to reflect on sleeping habits in the form of filling out a questionnaire regularly help in actively noticing positive changes, thereby also increasing the motivation to stay committed.

Apart from this overall research objective, the study and especially the developed routine program (also aimed to reduce the time it takes the participants to fall asleep) decrease the number of times they wake up during the night, increase the feeling of restfulness in the morning, and reduce tiredness during the day.

To draw conclusions about possible intercultural differences, the study was also conducted at Kwame Nkrumah University of Science and Technology in Ghana, a partner university of Technical University of Munich.

3 Methods

In the following, a detailed description will be provided of how the above-mentioned research objectives were methodically investigated and processed.

3.1 Development of a 30-Day Routine Program

The 30-day routine program, which formed the basis of the study, was developed conscientiously and based on scientifically proven measures by the project group. It consisted of 30 videos with a length of 7 minutes each, in which practical exercises for physical activity and information how to improve one's sleep hygiene were presented. The videos were produced by two members of the project group, assisted by an experienced videographer.

3.2 Surveys and Questionnaires

For the study, a total of 4 different questionnaires were developed, as seen in the following.

- **Initial survey (1x, pre-intervention):** Prior to study start, participants were given an initial questionnaire. Besides organizational questions, the participants had to answer questions relating to sleep and tiredness using the Bergen Insomnia Scale (BIS). Furthermore, prior knowledge about sleep hygiene was investigated by various questions. Both sections will be explained in further detail below.

- **Questionnaire about sleep in the previous night (daily throughout the study):** During the 30-day program, the participants were asked to answer a few questions about their sleep during the previous night each day after watching the exercise video. This questionnaire included, for example, the time it took one to fall asleep or the frequency of waking up during the night.

- **Survey about motivation (weekly throughout the study):** In a weekly rhythm, participants were asked about their general motivation to maintain the program or routine.

- **Final survey (1x, post-intervention):** In addition to general organizational questions, the participants should, as in the initial survey, answer questions relating to sleep and tiredness using the Bergen Insomnia Scale (BIS). Furthermore, a list of all sleep facts that were provided to the participants during the study was presented and the participants had to answer whether a sleep hygiene measure was new/surprising to them; if they had continued any of them so far; if they planned to continue one in the future; and if they were able to incorporate the sleep hygiene measure into their day-to-day life. Finally, the sleep hygiene knowledge questionnaire was given again, to check whether their knowledge level might have changed.

The Bergen Insomnia Scale (BIS) questionnaire [21], that was used in the initial and final survey, contains six questions (see Table 1). It is based on the Diagnostic and Statistical Manual of Mental Disorders [22], and aims to asses insomnia, with the first three questions being on the ability to fall asleep, stay asleep, and sleep enough, while the second three questions asses tiredness and sleep satisfaction. In the BIS questionnaire, the participants were asked to

answer on a scale from 1 to 7, whereby 0 meant no days during a week, while 7 meant every day during a week.

In addition to the BIS, participants were also asked to fill out a questionnaire on sleep hygiene knowledge in the initial and the final surveys (see Tables 2 and 3). Half of the participants were given the statements in Table 2, while the other half were given the statements in Table 3. The groups were randomly selected without regard to which study group the participants belonged.

The participants were asked to rate the statements on a scale from 1 to 7. Whereas for the BIS an answer of 0 meant no days and 7 every day during a week, for the sleep hygiene questionnaire, the scale from 1 to 7 measured their agreement with the given statements, whereby 1 meant *Strongly Disagree*, 2 *Disagree*, 3 *More or Less Disagree*, 4 *Unsure*, 5 *More or Less Agree*, 6 *Agree*, and 7 *Strongly Agree*. Half of the questions seen in Tables 2 and 3 were correct, meaning an answer of 7 is considered good, while the other half were incorrect, meaning 1 would be the correct answer.

Question	Number of days per week
During the past month, how many days a week has it taken you more than 30 minutes to fall asleep after the light was switched off?	0 - 7 days
During the past month, how many days a week have you been awake for more than 30 minutes between periods of sleep?	0 - 7 days
During the past month, how many days a week have you awakened more than 30 minutes earlier than you wished without managing to fall asleep again?	0 - 7 days
During the past month, how many days a week have you felt that you have not had enough rest after waking up?	0 - 7 days
During the past month, how many days a week have you been so sleepy/tired that it has affected you at school/work or in your private life?	0 - 7 days
During the past month, how many days a week have you been dissatisfied with your sleep?	0 - 7 days

Table 1: The Bergen Insomnia Scale (BIS) questionnaire contains 6 questions on sleep patterns and perceived tiredness [21]

3.3 Marketing and Recruiting

In order to draw attention to the study and recruit participants, different marketing strategies were implemented. On one hand, advertising posters were designed and placed at various locations around the TUM site. On the other, an Instagram channel served as a platform to raise awareness about the project and the possibility to register. In addition, promotional materials such as the poster and infographics were sent by e-mail to student councils and other TUM-affiliated organizations. The possibility of participating in the study was also raised by personal communication in the social environment of the project group. Participants were able to register for the study using a link via the portal “BayernCollab” whereby the registration period lasted about 5 weeks.

3.4 Participants and Study Groups

After the registration period, all registrants meeting the defined requirements were informed by E-mail about the further steps of the study. Applicants were disqualified if they met at least one of the following exclusion criteria:

- Not a student
- Pregnancy/Parenthood
- Major sleeping disorder
- Travelling to another time zone within the duration of the routine program
- Shiftwork

All participants were given an appointment to pick up a sleep tracker and sign further study documents. In total, 53 persons were officially introduced as study participants.

The participants were randomly assigned to three different study groups:

1. Group 1: Survey about motivation (weekly)
2. Group 2: Survey about motivation (weekly) + questions about sleep in the previous night (daily)
3. Group 3: Survey about motivation (weekly) + questions about sleep in the previous night (daily) + feedback on changes in sleep quality (weekly)

Number	Label	Statement	Source	Correctness
1	Consistent Sleep Schedule	Consistently waking up at the same time each day and going to sleep when the first signs of sleepiness emerge might contribute to better sleep hygiene.	[23]	True
2	Avoiding Caffeine	Avoiding caffeine within 8-10 hours of bedtime can improve sleep quality.	[24] [25]	False
3	Caffeine Intake	Caffeine intake in the morning after waking does not impact sleep quality.	[24] [25]	False
4	Light Exposure	Restricting exposure to bright lights, especially bright overhead lights, between 10 pm and 4 am might be associated with better sleep hygiene.	[26]	True
5	Short Naps Only	Limiting daytime naps to less than 90 minutes, or abstaining from napping, may be conducive to improved sleep quality.	[27] [28]	True
6	Pre-Bedtime Alertness	Expecting to feel highly alert approximately one hour before one's natural bed-time could be a characteristic of good sleep hygiene.	[29] [30]	False
7	Alcohol Consumption	The consumption of alcohol has no effect on sleep patterns.	[31]	False
8	Sleep Environment	Maintaining a cool sleeping environment may be a factor that improves sleep.	[31]	True
9	Sleep Needs	Sleep needs are individual and constant in adult humans.	[31]	False
10	Sleep Flexibility	Being able to fall asleep "anytime, anywhere" is a sign of a healthy sleep system.	[31]	False
11	Sleep Duration	Many adults need only 5 or fewer hours of sleep for general health.	[31]	False
12	Adaptability	Your brain and body can learn to function just as well with less sleep.	[31]	False

Table 2: Version 1 of the Sleep Hygiene Knowledge questionnaire, developed by the authors based on behavioral and environmental recommendations intended to promote healthy sleep. Participants were asked to rate statements on a scale from 1 (Strongly Disagree) to 7 (Strongly Agree) based on their knowledge and beliefs about sleep hygiene.

Number	Label	Statement	Source	Correctness
13	Adults' Sleep Patterns	Adults sleep more as they get older.	[31]	False
14	Sleep Quantity	If you can get it, more sleep is always better.	[31]	False
15	Sleep Timing	In terms of your health, it does not matter what time of day you sleep.	[31]	False
16	Rest vs. Sleep	Lying in bed with your eyes closed is almost as good as sleeping.	[31]	False
17	Weekend Sleep	Sleeping in on weekends is a good way to ensure you get adequate sleep.	[32]	False
18	Sleep Difficulties	If you have difficulty falling asleep, it is best to stay in bed and try to fall back to sleep.	[31]	False
19	Snoring	Although annoying for bed partners, loud snoring is mostly harmless	[31]	False
20	Afternoon naps	If you are having difficulties sleeping, taking a nap in the afternoon is a good way to get adequate sleep	[31] [33]	False
21	TV Before Bed	Watching television in bed is a good way to relax before sleep	[31]	False
22	Boredom and Sleepiness	Boredom can make you sleepy even if you got adequate sleep before	[31]	False
23	Exercise and Sleep	Exercising within 4 hours of bedtime will disturb your sleep	[34]	False
24	Sunlight Exposure	Exposure to natural sunlight after waking and again in the late afternoon, prior to sunset, may positively impact sleep quality	[35]	True

Table 3: Version 2 of the Sleep Hygiene Knowledge questionnaire, developed by the authors based on behavioral and environmental recommendations intended to promote healthy sleep. Participants were asked to rate statements on a scale from 1 (Strongly Disagree) to 7 (Strongly Agree) based on their knowledge and beliefs about sleep hygiene. The questionnaire was aimed at measuring the participant's knowledge about routines and techniques impacting sleep quality and their belief in so-called sleep myths.

3.5 Study Design and Procedure of the Investigation

The 30-day intervention was preceded by a one-week pre-intervention phase, in which participants had to complete an initial survey. The sleep of the participants was already being tracked during this time. Afterwards, the 30-day intervention started, in which the participants were presented with a 7-minute exercise video every day. They were recommended to watch the video and follow the exercises directly after waking up in the morning. Furthermore, participants were provided with information on good sleep hygiene and their sleep was tracked with a sleep tracker. This was followed by a one-week post-intervention phase, in which sleep was still tracked. At the end, a final questionnaire was presented to the participants. Depending on which group the participants were assigned to, in addition to a weekly survey (Group 1, 2, and 3) they were asked daily questions about their sleep during the previous night (Group 2 and 3). Group 3 was additionally given feedback weekly about changes in their sleep.

4 Results and Discussion

4.1 Study in Germany

4.1.1 Bergen Insomnia Scale (BIS)

The study was conducted amongst 56 students aged 18 to 30 years (mean age of 23.1 years, 56% female) at TUM, of which all filled out the initial survey and 29 the final survey. In both surveys the participants were asked to complete the Bergen Insomnia Scale (BIS) questionnaire containing six questions (see Table 1), where 0 meant no days during a week and 7 meant every day. The average answers to the BIS questionnaire split up into the three subgroups before (blue) and after (yellow) the study are shown in Figure 1. The key finding derived from Fig. 1 is a notable amelioration in participants' subjective assessments of insomnia symptoms throughout the 44-day duration, observed consistently across all queried domains and experimental subgroups. Also, it is worth noting that the students participating in the study indicated that they struggled most with feeling rested after waking up and overall sleep satisfaction, while waking up at night for

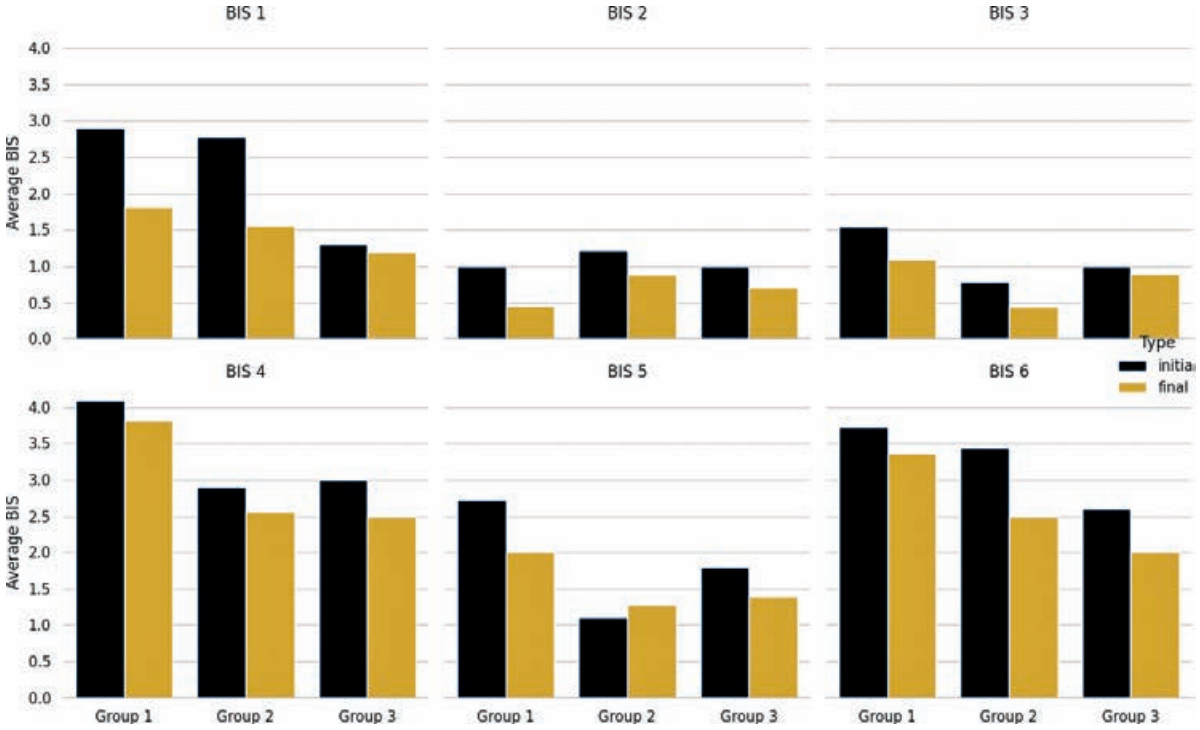

Figure 1: Average answer to the Bergen Insomnia Scale (BIS) questionnaire of all 29 German participants finishing the study, before (blue) and after (yellow) the study, split up into the subgroups

longer periods and waking up earlier than intended were not major issues. A large-scale study amongst 50054 students in Norway conducted in 2018 also used the BIS to assess insomnia [36] and found that 34.2% of female study participants suffered from insomnia while it was only 22.2% in men. Overall a strong increase in insomnia from 22.6% in 2010 to 30.5% in 2018 was observed [36]. The average of 30.5% is because only three in ten participants were men. The criteria for the assessment of whether a participant suffered from insomnia were the following: "(a) the presence of either DIS [Authors' note: DIS stands for "difficulties initiating sleep," and is in the following treated as being equal to question 1 in Table 1], DMS [Authors' note: DMS stands for "difficulties maintaining sleep," and is in the following treated as being equal to question 2 in Table 1] or EMA [Authors' note: EMA stands for "early morning awakening," and is in the following treated as being equal to question 3 in Table 1] for at least 3 nights per week; (b) the presence of daytime sleepiness and tiredness [Authors' note: in the following, this is treated as being equal to any of the questions 4-6 in Table 1] for at least 3 days per week; and (c) a duration of the sleep problems for at least 3 months."

Applying an equivalent method to determine the prevalence of insomnia in our participants prior to the study, excluding the duration criteria (i.e., sleep problems lasting at least 3 months, which were not evaluated), we find that 36% suffered from insomnia before the intervention. This aligns closely with reported rates in Norway.

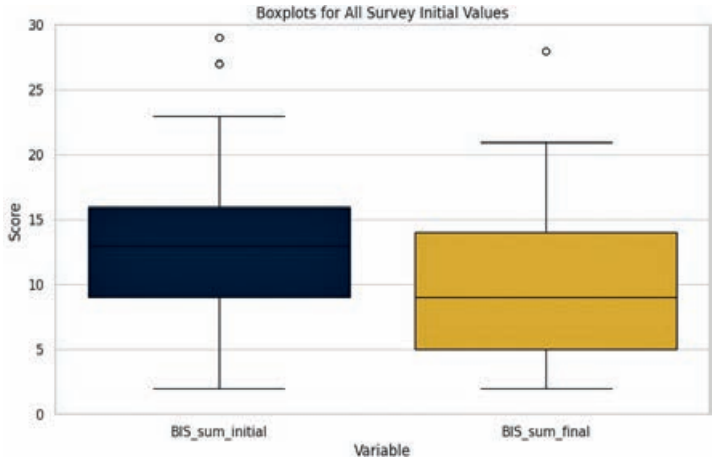

Figure 2: Box plot of the BIS median composite score for the initial (blue) and final survey (yellow)

The median composite score of the BIS in our study before the intervention was 13, and 9 after the intervention (see Fig. 2). In a 2023 study the capability of mindfulness-based cognitive therapy (MBCT) to improve insomnia symptoms was tested in 55 individuals with recurrent depression with a mean age of 40.7±12.9 years, of which 74.5% were females. The intervention lasting 8 weeks was successful in reducing the average composite score of the BIS in the MBCT group by 5.8 points from an initial score of 20.6±8.1 on the BIS score compared to an increase by 1.1 points in the waitlist control group [37]. The mean composite BIS score of the participants who completed the study by filling out the final survey declined by 4 points in our study and by 5 points for participants classified as "insomniacs" at the start of the study. We observed no improvement for participants with no insomnia symptoms at the start of the study. While we did not have a control group in the study, the findings of the participants who completed the study, alongside the findings on the evolution of the waitlist control group of the Norwegian study [37] on MBCT, suggests that our multi-component intervention can help decrease symptoms of insomnia. Moreover, 95% of the participants with insomnia symptoms completed the intervention, indicating a high level of adherence and engagement with the multi-component program for the target group.

To further support the claim of an improvement in insomnia symptoms, we utilized a method known as a "random walk." A random walk describes a process in which a step in any allowed direction is equally likely and determined at random. This method is a good tool to simulate the evolution of a system, especially when multiple external factors introduce unpredictability.

In our case, we studied the evolution of the BIS score over 30 steps, each step representing a day of the intervention. We assume the step size, i.e. how much the score changes from one day to another, to be equal to 1 point on the BIS. We also allow for the BIS score to remain at its current value, which corresponds to a step size of 0.

We then compared a pure random walk, where the likelihood of the BIS score increasing, decreasing, or remaining the same is equal, to a random walk with a trend. In the latter, although the direction of each step remains random, the probability of the BIS score decreasing is greater than the probability of it increasing.

In Fig. 3 we show the evolution of the standard deviation and mean for the pure random walk method (blue) and the random walk with

a trend (orange) averaged over 30 trials. In each trial we bounded the BIS scores to lie within [0, 42] by ignoring steps that would exceed these bounds. In the blue random walk, we assume equal probabilities of one-third for each of the following outcomes: an increase, a decrease, or no change in the BIS score. On the other hand, the orange random walk assumes a one-third probability for the BIS score to remain the same at each step, a 45% probability of a decrease, and only a 22% probability of an increase.

While the specific values of the random walk simulation may not describe the actual evolution perfectly (for instance, we expect the improvement to not kick in from the start and flatten with increased time), the simulation serves as a visualization of the positive impact our intervention has.

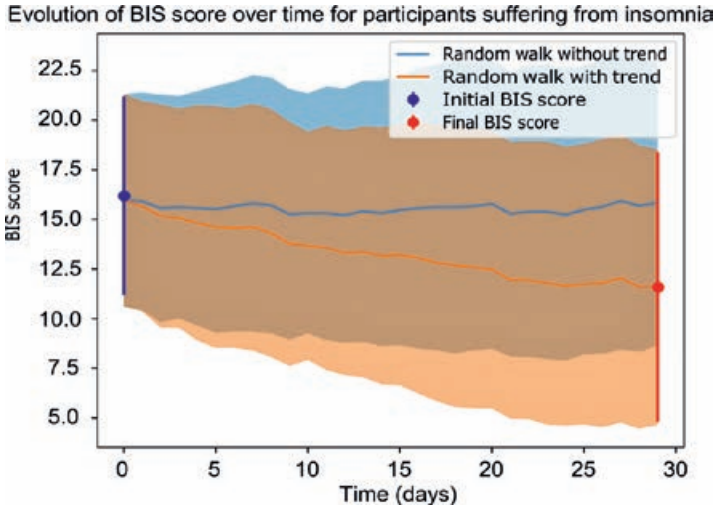

Figure 3: The blue (initial) and red (final) error bars show the mean and standard deviation of the initial and final BIS scores of participants with insomnia symptoms, while the blue (equal probability of increasing p_{worse} and decreasing p_{better} the BIS score) and orange (p_{better}/p_{worse} = 1.35) lines show the evolution of the mean BIS scores and standard deviations assuming an underlying random walk.

4.1.2 Sleep Hygiene Knowledge

The sleep myths were debunked, and sleep hygiene knowledge was disseminated during the 30-day intervention by including a short fact at the end of the workout videos the participants were supposed to watch each morning. These sleep facts addressed all the statements given in the initial survey.

After the intervention, the participants got a survey again including the BIS questionnaire and the sleep hygiene knowledge questionnaire with the same set of questions.

We expect the answers regarding sleep myths to follow a bimodal distribution with participants either believing them to be correct or incorrect. For these questions we report the percentage of agreement and disagreement and their certitude, as the average value within the two subgroups (see Table 2).

For the questions on knowledge that impacts sleep quality that is not directly tied to a sleep myth, we expect the answers to be normally distributed with a mean of 3.5, meaning there is no knowledge about the technique/ routine among the study population.

26 out of the 54 initial participants filled out the final survey, and only those 26 were considered for the evaluation of the sleep hygiene knowledge improvement. To assess how their sleep hygiene knowledge changed, the difference between the answered value was calculated, where a positive difference means they became more sure of the correct answer. The result is shown in Figure 4 per participant and question.

To analyze the overall improvement per participant, the differences were then summed up, so that a lowest value of -72 could be reached for maximum deterioration, or a high of 72 for highest possible improvement. As seen in Figure 5, the mean improvement is at 0.38, with the median value at 0.5. This increase is not significant. One reason could have been that the participants only got the correct information once and a retention of the information over an extended period is unlikely. However, we expected “motivated” participants to improve nevertheless either by reading up on sleep hygiene knowledge privately or by paying close attention to the information in the videos, and by incorporating the positive tips into their daily routines and avoiding habits with negative impact on their sleep.

4.1.3 Motivation of participants

To assess the impact of incentives for active reflection and providing feedback on the motivation of the participants two main data points were analyzed: The number of participants that dropped out of the study and the time they spent watching the daily video. As threshold for a participant to be considered as “dropped out” we defined skipping two videos in a row or five videos in total. Monitor-

ing dropout rates is generally essential to monitor as they can impact the validity and reliability of study results. High dropout rates may indicate issues with participant engagement, study design, or intervention effectiveness.

An overview of initial number of participants, total dropouts and the percentage of dropouts for each study group is shown in Figure 6. Group one exhibits the highest dropout rate, with more than 60%, while group two has a rate of about 50% and in group three, less than 40% dropped out.

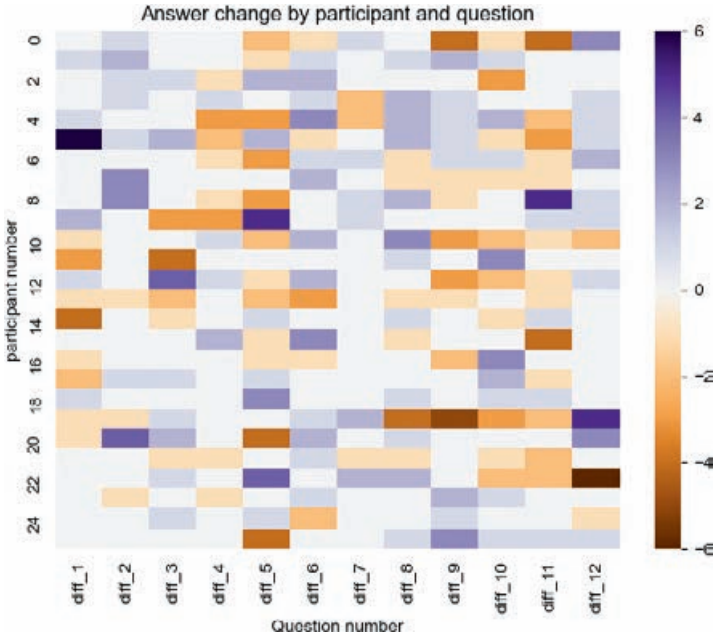

Figure 4: Difference in answer confidence per participant and question. Both question sets one and two are combined.survey (yellow)

This suggests potential concerns with participant engagement or the effectiveness of the video-only intervention. Based on these results, strategies to improve participant retention, such as enhancing intervention content, providing incentives, or implementing reminders, seem more effective than only providing the routine content. Further investigation of reasons for dropout, such as participant demographics, preferences, or study-related factors, could promote development of targeted interventions to mitigate dropout rates and improve overall study success.

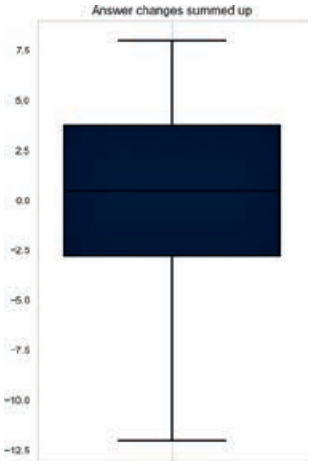

Figure 5: Answer confidence differences summed up per participant.

The second metric investigated is the time the participants spent on the survey page with the video. Spending less time than the video duration might imply a loss of interest or skipping parts of the intended routine. Based on the length of the videos, where the shorter ones are about 367 seconds and some time was deducted for intros and outros, a threshold of 350 seconds was set for a participant to have spent 'enough' time on that website. From the p-values calculated for the results shown in Figure 7, no significant difference between the groups could be found.

4.2 Study in Ghana

After the study in Munich concluded, the team traveled to Kwame Nkrumah University of Science and Technology (KNUST) to set up the study there as well. The same study design as described in section 3 was used. Because of time constraints and significant differences in how student projects are approached in Ghana, the way participants were selected differed: In Germany, all students could voluntarily join if they had interest in the topic of sleep improvement, and they were only incentivized by advertisement or word of mouth.

At KNUST however, advertisement possibilities were limited, so most of the communication to students was through visiting lectures and introducing the project. Afterwards, to help gain enough participants, the lecturers advised certain students of their classes to join our program. The selection of students was based on their perceived reliability in handling and returning the sleep trackers that were given out.

This factor might have led to a different general motivation to participate in the study compared to the German students. It is therefore important to note that it is difficult to amalgamate the two data sets

from Germany and Ghana. Some comparisons of notable values are shown in the following, but they have to be viewed with caution.

4.3 Difference in Sleep Hygiene Knowledge and BIS score between Ghana and Germany

As part of our study, we investigated how sleep routines and habits, motivation, and knowledge vary between different regions of the world, specifically Germany and Ghana, and how this affects the outcome of the 30-day sleep quality and sleep routine improvement program. Independent of the differences between the studies in Germany and Ghana, outlined in section 4.2, an assessment of different sleep hygiene knowledge in Germany vs. Ghana was done. Fig. 8 shows the average scores for sleep hygiene knowledge questions from 1 (Strongly Disagree) to 7 (Strongly Agree) of Tables 2 and 3 in Germany and Ghana sorted in descending order by the difference in points between the German and the Ghanaian students' answers.

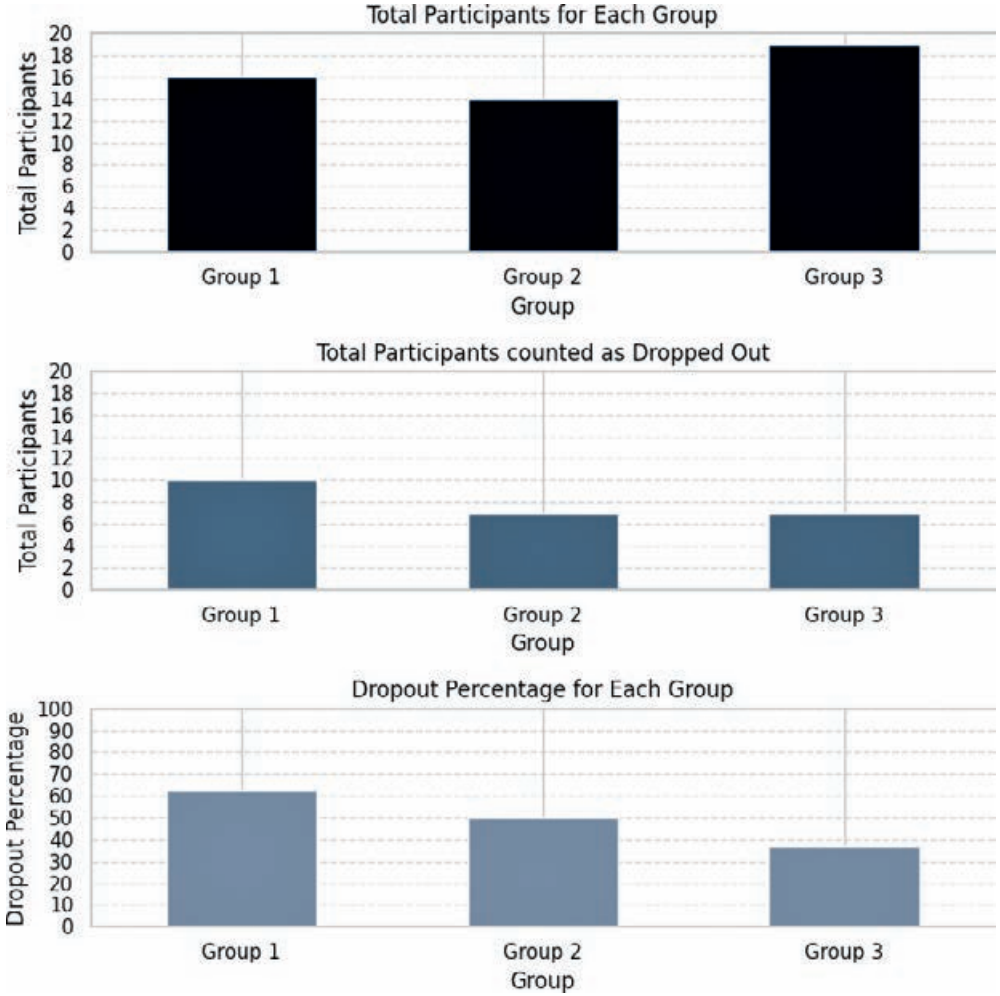

Figure 6: Counts of all participants (top), dropped out participants (middle), and the dropout percentage (bottom) for each of the subgroups.

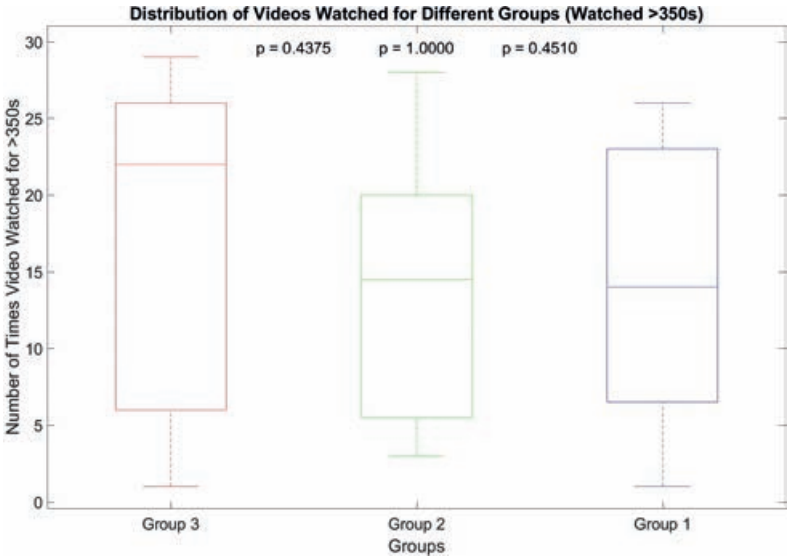

Figure 7: Amount of Videos watched for more than 350s based on total time spent on the webpage, for Group 1 (right), Group 2 (middle) and Group 3 (left)

It is worth noting that there was a significant discrepancy (over 1.5 points) in the average agreement with the top 10 statements. Also, for statements 21, 14, 6, 18, 9, and 17, the German students tended to disagree more, while the Ghanaian students tended to agree more with the statements.

A more precise comparison for each question is depicted in Figure 9, in which the six questions with the biggest difference were compared using boxplots for each of the two participant groups. Particularly noteworthy is the difference in confidence for particular questions. While for question 21 and 14, German students were more undecided in their answer, Ghanaian students showed a much more uniform agreement with the statements. On the other hand for question 11, German participants were very uniform in their denial of the thesis, while Ghanaian participants were much more undecided.

Figure 10 shows a similar comparison of pre- and post-intervention BIS scores for the participants of the Ghana study. While the improvement was even less than for German participants, it is worth noting that participants in Ghana started with a much higher BIS score on average than German participants.

	Merged_df_Avg	Initial_Ghana_Avg	Difference
Hygiene_21	2.411765	5.391304	2.979540
Hygiene_14	3.470588	6.260870	2.790281
Hygiene_6	2.538462	5.318182	2.779720
Hygiene_11	1.461538	3.545455	2.083916
Hygiene_18	3.235294	5.217391	1.982097
Hygiene_9	3.538462	5.409091	1.870629
Hygiene_15	2.176471	4.000000	1.823529
Hygiene_17	3.647059	5.347826	1.700767
Hygiene_3	3.307692	4.909091	1.601399
Hygiene_7	1.307692	2.772727	1.465035
Hygiene_13	2.352941	3.652174	1.299233
Hygiene_16	2.529412	3.565217	1.035806
Hygiene_12	1.692308	2.727273	1.034965
Hygiene_24	5.529412	4.652174	0.877238
Hygiene_20	4.294118	5.086957	0.792839
Hygiene_4	6.000000	5.272727	0.727273
Hygiene_5	5.538462	4.818182	0.720280
Hygiene_22	4.882353	5.521739	0.639386
Hygiene_19	3.294118	3.869565	0.575448
Hygiene_10	3.000000	3.545455	0.545455
Hygiene_23	3.764706	4.173913	0.409207
Hygiene_2	6.615385	6.272727	0.342657
Hygiene_1	6.076923	5.909091	0.167832
Hygiene_8	6.076923	6.227273	0.150350

Figure 8: The figure shows the average scores reflecting the agreement/ disagreement with the statements provided in the sleep hygiene knowledge questionnaire between the study participants from the Technical University of Munich in Germany and the participants from the Kwame Nkrumah University of Science and Technology in Ghana, sorted by the difference between the German and Ghanaian students.

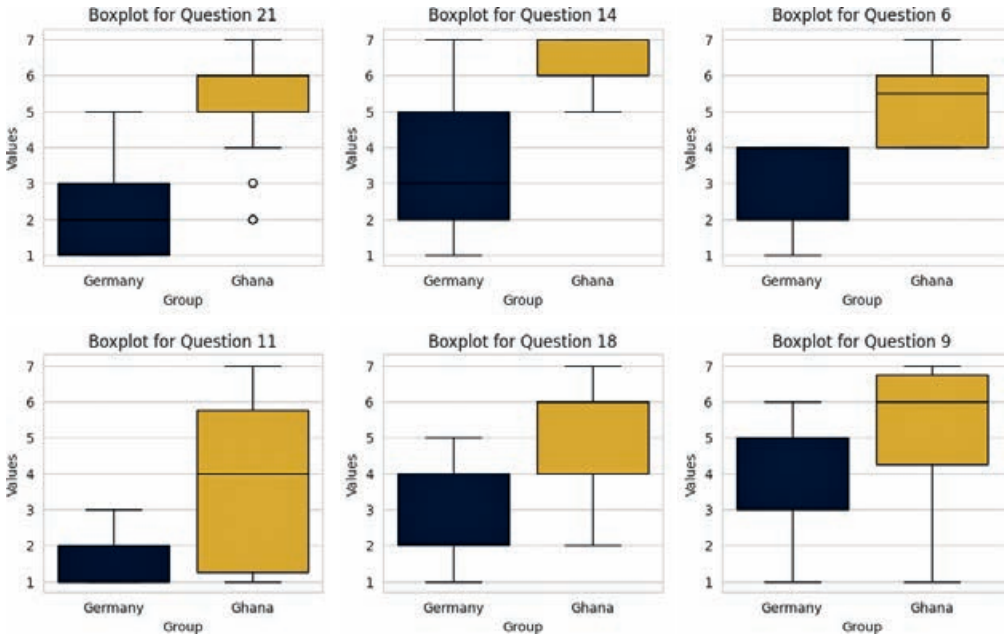

Figure 9: Boxplots for the six questions with the biggest average knowledge difference between the countries, each time comparing German (blue) and Ghanaian (yellow) students. The exact questions are stated in Table 2 and Table 3

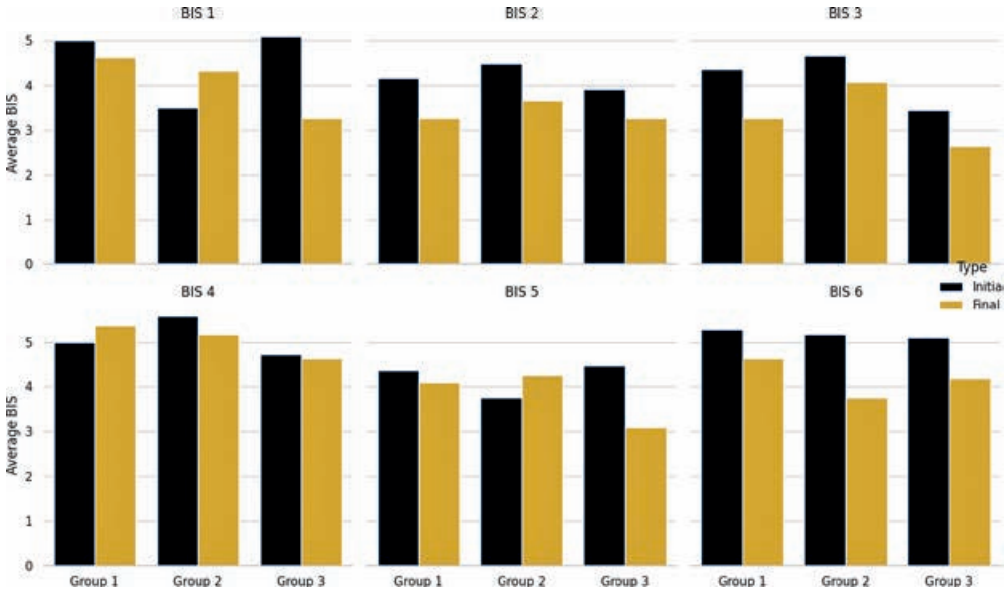

Figure 10: Average answer to the Bergen Insomnia Scale (BIS) questionnaire of Ghanaian participants, before (blue) and after (yellow) the study, split up into the subgroups

5 Conclusion

The observed reduction of BIS scores across all subgroups with a median composite score decreasing from 13 before the intervention to 9 afterwards, coupled with the significant improvement noted in participants identified as ”insomniacs” at the study’s outset, provides some evidence that the multi-component intervention including sleep education, physical exercise, and relaxation techniques, has a positive impact on subjects suffering from insomnia. Furthermore, the high completion rate of 95% among participants with insomnia symptoms, suggests that the intervention achieved a high attention rate and thus has the potential to address sleep disturbances effectively, especially among university students.

Significant differences between the subgroups 1 (only weekly surveys), 2 (weekly survey and daily questionnaire) and 3 (weekly survey, daily questionnaire and feedback on sleep quality), indicating that receiving feedback and incentives for active reflection are essential for enhancing sleep quality over the 30-day period were not observed. However, the lower dropout rates for the group receiving feedback and reflecting on their sleep by keeping a sleep diary suggests that motivation for study continuation is impacted. The non-significant level of improvement in sleep hygiene knowledge before and after the study suggests that a brief sleep fact presented after a daily workout routine may not suffice to enhance understanding of positive sleep practices. Thus, future interventions may benefit from exploring alternative techniques for disseminating knowledge to enhance this aspect of the intervention.

6 Acknowledgements

We want to thank Nils, especially for filming and editing the exercise videos used in the intervention. Also a big thank you to our supervisors Prof. Dr. Manuel Spitschan and Prof. Dr. Philipp Reiß, our tutors Genoveva Müller and Elisa Rodepeter, and the office team around Constanze, Dennis and Peter for all the help and guidance during the 20 months. Last but not least, thank you to the TUM: Junge Akademie as well as the Freunde der TUM e.V. for ideological and financial support in conducting our research.

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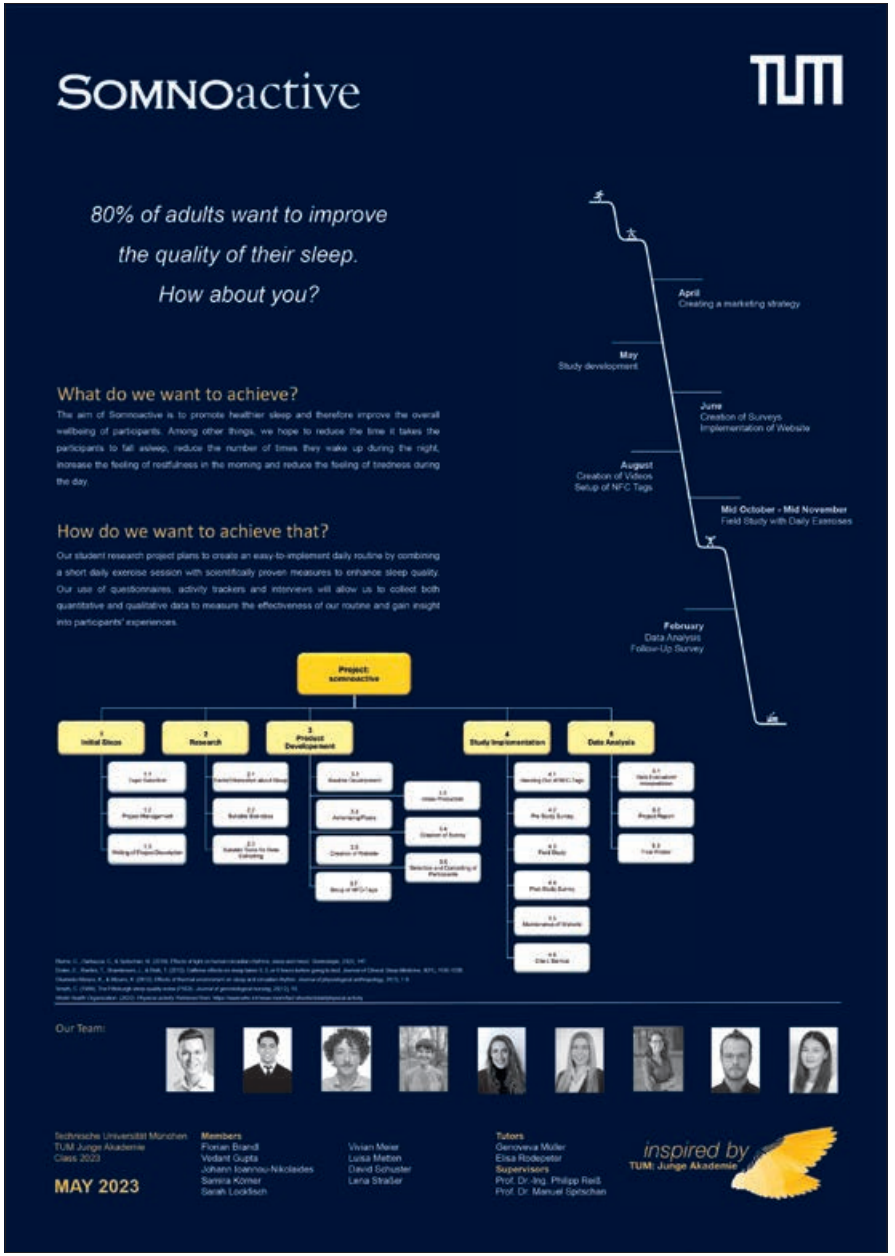
Self-reflection


Guys, we should do a team building event!
VEDANT
To be completely honest...
I like the idea!
VIVIAN
Protocol Meeting 378
- submit Poster number 13
- write a wiki a about w
- do cri
LENA
Should've done the other project idea ...
DAVID
2/2
Leave



POSTER 1:

Starting from the kick-off weekend in November 2022, we initially wanted to develop pilot projects on the subject of air pollution. After encountering several practical difficulties with that, we reconsidered within the group and decided to focus on the topic of sleep in combination with physical activity instead. The intent of our group "Somnoactive" was to promote healthier sleep and to improve the overall wellbeing of participants. Therefore, we planned to create an easy-to-implement daily routine by combining a short exercise with scientifically proven measures to enhance students' sleep quality.

To get a deeper insight into the topic, we conducted thorough research on the subject of sleep and adequate exercises as well as suitable tools for data collection.

POSTER 2:

After finishing our main research, we formulated a research question and a hypothesis for our study and defined a concrete study design.

Within four subgroups, it was our goal to advance the study as effectively as possible: While one team addressed the ethical aspects of our study, another group worked on the planning and implementation of the daily exercise videos we wanted to present to our participants. In addition, a third team took care of the project marketing and acquisition of participants and the last group dealt with how the videos and surveys could be made available to the participants.

POSTER 3:

After our study was promoted successfully, all exercise videos were recorded and everything was prepared, the project started on November 2, 2023, with students mainly from TUM – a first milestone of our project was realized. We were able to collect data throughout the 30-day-intervention and during pre- and post-intervention periods of one week each. We also started to evaluate the data and gained a first insight into the results.

Besides that, we planned a trip to Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi/Ghana, a partner university of TUM, to conduct the same study there.

POSTER 4:

Right after a TUMJA weekend seminar in January 2024, five members of our team travelled to Kumasi/Ghana for one week to prepare and help with the start of the study on site at KNUST. Besides this scientific aspect, we were also able to meet great personalities and to gain amazing insights into the country, its culture and its customs – an incredible and unique experience.

We continued with data evaluation, compiled the most important results and finished the writing of our research report.

During the final stage of the scholarship program, we planned the presentation of our project at the TUMJA symposium in June 2024.

Research Report **Tick Talkers**

Lyme borreliosis is the most common tick-borne disease in Germany. As ticks are influenced by climatic factors, we used data on temperature and precipitation from 2016 to 2022 in Bavaria to develop a model predicting the future incidence of Lyme borreliosis. Despite some limitations, our model helps to better understand future trends of Lyme disease incidence and provides actionable information for the public to develop prevention strategies and raise awareness for tick bite prevention and treatment.

Team
Carolin Niedermaier
Claudia Guadarrama Serrano
Letizia Wörrlein
Shaoming Zhang
Franka Exner
Xufan Lu

Tutors
Daniel Khadra
Leonardo Marco Giannotti

Supervisors
Prof. Niklas Fanelsa
Prof. Dr. Enkelejda Kasneci
Yao Rong

Preface by the Supervisor

Prof. Niklas Fanelsa

Staying together in a natural setting, away from daily routines and the city, while sharing knowledge and working together, is a good approach. Walking in nature, taking a swim, and sharing local food make up a holistic experience. Workshops and sessions led by renowned scientists and experts create an immersive learning environment. These strategies influenced the foundation of the historic Black Mountain College (1933–1957) and resonate with the principles of TUMJA.

Well-designed spaces play a crucial role in fostering creativity and knowledge creation. I have had the opportunity to experience various seminar spaces around Munich selected by TUMJA for their gatherings. It is only logical that TUMJA envisions its own seminar house to reflect its values and ideas. As a member of TUMJA, I therefore support the establishment of a new seminar house. At Starnberger See, TUM has the unique opportunity of transforming the historic Hans-Albers-Villa, to create a space for international exchange and mutual learning.

As a first involvement, I had the chance to co-organize a student workshop in April 2024, focusing on the new cladding of the reed roof. Together with professional craftsmen, seventeen students had the opportunity to get their "hands on reed" at the existing boat house. They will probably still remember which pieces they added once they return to the finished seminar campus as alumni.

Supervisor insights

What special experience from your studies/career would you like to share with the scholars?

We have to address the current Polycrisis by understanding its wicked problems in order to design intelligent solutions. Teams with multi-perspective views from diverse backgrounds have the best chances of succeeding in this challenging task. The teams of TUMJA lay the foundations for the future team engagement of its members.

What does mentoring the team mean for your own research?

For me, mentoring means sharing knowledge at eye level while being open and curious. Coming from a design background, I value TUMJA for exposing me to professionals and students from natural sciences and social sciences with methods and knowledge production that are uncommon to my field of research. Through this, I get a better understanding of how collaborations that draw on different backgrounds can complement each other.

Supervisor insights
Prof. Dr. Enkelejda Kasneci
As the supervisor of Tick Talkers, I am delighted to see the team's development through the TUMJA program in conducting research, working collaboratively, and managing tasks. Their journey began with brainstorming and identifying a relevant research question. Drawing on their diverse expertise, they chose to focus on the impactful topic of climate change and Lyme disease infection. Through the project's execution, they gained valuable experience in cutting-edge technologies such as Artificial Intelligence and Machine Learning. At the science fair, they successfully introduced and advertised their work, earning recognition from all attendees. I am confident this synergy will continue to drive each team member's development and inspire further achievements.

What was your best TUMJA moment?
I was proud and impressed when the team reached out to a biomedical professional and successfully obtained an expert opinion. This step showed their confidence and motivation for the project, turning their enthusiasm into meaningful and proper action. Such a move is challenging yet essential in every researcher's development, and at that moment, I felt the TUMJA mentoring program had paid off. ■

By year 2050 the incidence of Lyme disease in Bavaria, Germany will have risen to more than 1000 per year

An interdisciplinary group of students named Tick Talkers recently established a predictive model linking climate factors to the number of ticks and Lyme disease in Bavaria. The project was developed under the framework of the TUMJA and aims to predict future numbers of ticks and Lyme disease cases in different regions of Bavaria.

As there is an established link between climate factors and ticks, not only scientists and health professionals but also the general public will direct attention towards changes in the spread of tick-borne diseases. From hikers navigating Bavaria´s countryside, residents in endemic regions, to healthcare systems, the implications of this complex relationship requires the need for proactive measures and increased awareness.

For the creation of this model, historical data of reported cases of the disease and climatic factors, such as temperature and precipitation were utilized. The data was gathered in Bavaria from 2016 to 2022. The model showed that the incidence of the disease is closely linked to climatic factors. The interplay of milder winters and variability in precipitation have created an environment conducive to the proliferation of ticks carrying Borrelia, the pathogen causing Lyme disease. The research also draws parallels with similar events in other parts of Europe and the USA.

Lyme disease is an infection caused by a bacterium (*Borrelia burgdorferi*) which is hosted by ticks. The bacterium, and thus the infection, is transmitted to humans using the tick as a vehicle. Typical symptoms appear as skin rashes, joint and muscle pain, headaches, and fatigue. Early detection of the bite and antibiotic treatment by medical doctors can treat the disease. However, if left untreated, the pathogen can spread to the nervous system, joints, and heart, followed by long-term health issues.

To make those predictions accessible to the general public, the Tick Talker group created an interactive website, with information about estimated numbers of ticks in different regions of Bavaria. Thereby, zones at high risk of infection are highlighted to caution the public. Additionally, the website informs users of general information about ticks and the disease and protection against tick bites. Also, tips on what to do in case of a tick bite and further information can be found.

Despite protecting individual health using preventative measures such as vaccination and tick checks, early detection of a potential increase in high-risk areas becomes a broader concern. The situation underscores a broader societal implication requiring a collective response to effectively allocate resources and mitigate the escalating threat. ■

Research Report – Tick Talkers

Abstract
Lyme borreliosis, an infectious disease transmitted by ticks, is the most common tick-borne disease in Germany. After infection has happened, the disease is divided into three clinical stages. In the early stage, the infection can be treated with antibiotics, while late manifestations can severely affect a person's health and quality of life. Therefore, the early detection of a tick bite and prediction of future incidence rates can improve resource allocation and communication with the public. As ticks are influenced by climatic factors, we used data on temperature, precipitation, and sunshine duration from 2016 to 2022 in Bavaria to develop a model predicting the future incidence of Lyme borreliosis. We fitted an autoregressive moving average (ARIMA), a statistical analysis model used to forecast future trends. Thereby, the variable of interest is influenced by both current and past values of the independent variables. In addition to strong correlations between the input variables and the outcome measure, a temperature rise of 2.8 °C is expected to result in a 5%-10% increase over current levels. However, the complex disease dynamics and the lack of land use data may affect the accuracy of our predictions. Despite these limitations, our model helps to better understand future trends of Lyme borreliosis incidence and provides actionable information for the public to develop prevention strategies and raise awareness of tick bite prevention and treatment.

Background
Lyme Borreliosis (LB) is the most common tick-borne disease in Germany (Böhmer, et al., 2021). In 2023, Skufca et al. reported an annual incidence of 37.2 per 100,000 person-years on average from 2016 to 2020 (Skufca et al., 2023). Böhmer et al. showed comparable results with an annual incidence of 34.3 cases per 100,000 inhabitants in Germany from 2013 to 2020 (Böhmer et al., 2021). The lowest rates were found in 2015 with 23.2 cases per 100.000 and the highest were found in 2020 with 47.4 cases per 100.000 person-years. Nevertheless, an approximately ten-fold higher number of unreported cases is estimated.

Even though Germany is a high-risk country for LB, it is not a notifiable disease in 7 out of the 16 federal states. That explains that the actual number of LB cases is estimated to be higher than those that were reported. When analyzing the annual incidence, it is noticeable that 68% of all LB cases were reported between June and September. There is a high variation in the risk of Lyme disease depending on region, season, temperature, and a variety of other factors.

After infection by *Borrelia burgdorferi* has happened, the disease can be divided into three clinical stages. The first stage is on the skin, lymphatic, and nervous system. Following the early dissemination phase, the heart and musculoskeletal system can also be affected. Occasionally eyes are affected as well (Girschick, H. J., et al., 2009). Finally, chronic neuroborreliosis can develop, which might disrupt cognitive functions, change behavior, and impact gait stability and bladder function (Koedel et al., 2015).

As late manifestations of the disease have a severe impact on an individual´s health and quality of life, it´s important to prevent and detect tick bites early. Therefore, awareness of the following symptoms indicating an infection should be raised.

Nowadays, infected patients are treated with intravenous injections of penicillin, ceftriaxone, and cefotaxime or oral intake of doxycycline. (Girschick, H. J., et al., 2009). A vaccine for Lyme Disease developed by Pfizer and Valneva is currently being tested in clinical studies, according to the latest press release, with the expected trial conclusion date by the end of the year 2025 (Valneva & Pfizer, 2023). However, as further evaluation is needed, the vaccine is not available for the public. Therefore, knowledge about the pathology of this disease and the importance of its prevention is still crucial.

In Europe, *Ixodes ricinus* is one of the most abundant and widespread ticks and transmits LB and tick-borne encephalitis (TBE). The complete life cycle of a tick takes around 2 years to complete. It starts in spring when an adult female tick lays a batch of eggs. During summer, the larvae (6 legs) emerge and typically feed on small animals, like mice. This interaction between the host and the different life stages of the vector can be seen in Figure 1.

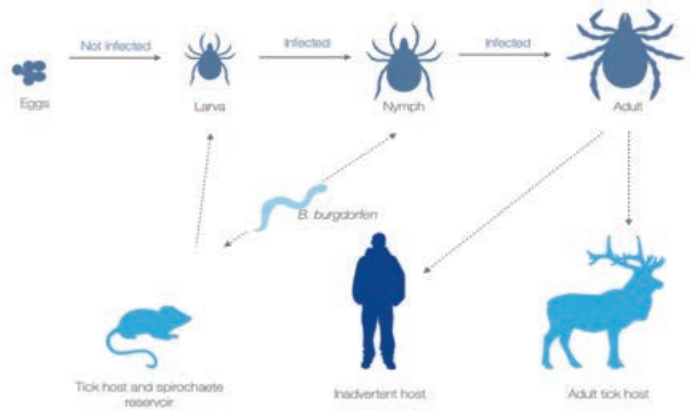


Figure 1: Vector and host relationship.

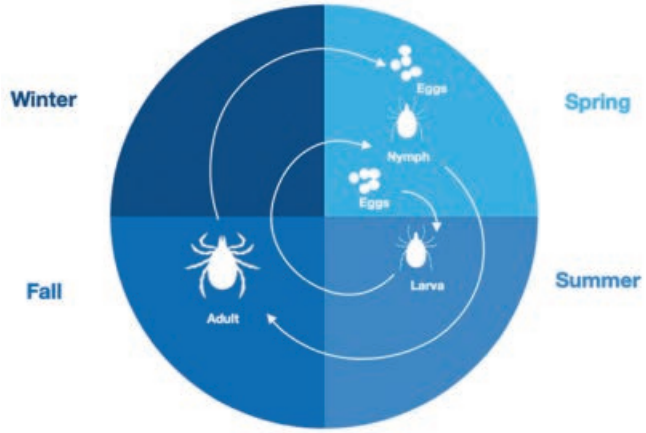


Figure 2: Tick life cycle through a year.

The mice are reservoirs for the bacteria that cause diseases, such as LB. The tick larvae can obtain the bacteria from them. During late summer, these larvae continue to grow into nymphs (8 legs). During winter, these nymphs stay alive under leaf debris.

In the second year, during spring, the nymphs emerge and feed on medium-sized animals. During this stage, nymphs are considered to be at the most dangerous life stage, regarding their infection risk. This is because they have a small size, therefore are hard to spot, and there is a high possibility of being infected with bacteria.

During the late summer, the nymphs grow into full adults. Once they reach a bigger size, the ticks feed on larger animals, such as deer. During fall and winter, the adult ticks can remain active, if the temperatures are above freezing point. The life cycle of the ticks based on the seasons of the year is shown in Figure 2.

The number of ticks, especially those infected with LB, is of major relevance. A study on Lyme Borreliosis in Germany from 2010 to 2019 showed that 5-22% of all ticks were infected with Borrelia. Whereas there were lower numbers in the north of Germany with approximately 5% of infected ticks in Mecklenburg-Vorpommern, in Bavaria, and in Baden-Württemberg, 12,8% and 22% of all ticks were found to be LB carriers (Akmatov et al., 2021).

The World Health Organization defines health as complete physical, mental, and social well-being, emphasizing the interconnectedness of personal health with biological, environmental, social, and health system factors.

Climate change affects health directly and indirectly, with the well-being and health of humans, revealing an intricate relationship with the environment. Key associations include the impact of temperature and humidity on infectious diseases, mortality, respiratory, cardiovascular, and neurological outcomes (Rocque et al., 2021).

In the case of vector-borne infectious diseases, meteorological factors such as temperature, precipitation, humidity, and wind influence their incidence. Extreme weather events contribute to vector-borne disease risks, influencing broader consequences such as political instability, and health system capacity, among others (Rocque et al., 2021).

Ixodes ricinus, the predominant tick in Europe, along with *I. persulcatus*, transmits LB and consequently TBE. Climate change can influence tick behavior, with warmer winters increasing winter activity and hotter summers altering seasonal patterns. Ticks, sensitive to environmental conditions, are affected by changes in distribution and abundance due to climate variations (Gray et al., 2007).

Winter activity of ticks increases the risk of infectious tick bites for forest visitors. Climate suitability modeling, considering microclimatic variables, highlights the importance of ecological niches in tick distribution. Changes in tick abundance may be linked to long-term climate cycles rather than permanent shifts (Gray et al., 2007).

Predicted climate changes may impact vegetation structure, affecting tick habitats. While the link between LB incidence and climate change is uncertain, mild winters may extend tick activity seasons, potentially leading to increased disease prevalence (Gray et al., 2007; Vermont Department of Health, 2018).

Ixodes ricinus exhibits flexibility in seasonal activity, adapting to diverse conditions across its geographic range (Gray et al., 2007). The impacts of climate change on tick-related diseases are multifaceted, influenced by local conditions, socioeconomic factors and ecological dynamics.

Similar cases have been reported throughout Europe. In Stockholm a combination of climate variables affecting ticks showed a significant correlation with the incidence of TBE cases between 1960 and 1998 (Lindgren, 2001). Samplings made between 2001 and 2002 in the Czech Republic reflected changes in altitude distribution, where an incidence of ticks carrying TBE increased at higher altitudes relative to the field studies made in 1957 and 1979-1980 (Daniel et al., 2004; Danielová et al., 2006).

Climatic factors play a major role in the vector's life cycle. However, this correlation is not straightforward. Transmission of tick-borne infections involves complex interactions among reservoirs, vectors, and humans, with climate change affecting each stage differently. Despite evidence of climate-induced changes in tick survival and activity, the precise factors influencing disease incidence remain challenging to determine due to a multitude of interconnected processes.

Health framing in climate communication remains under-utilized, and there is a call for increased explicit linking of human health and climate change to engage wider audiences. Health professionals and policymakers play a crucial role in climate communication, adaptation and mitigation, as adverse health outcomes will strain health systems and their workforces (Rocque et al., 2021). Recognizing the diversity of health impacts and addressing research gaps will aid in preparing for the escalating health challenges posed by climate change.

Predictive modeling plays a role in forecasting the incidence of infectious diseases in the future by learning from the past. It is already being applied, for example, in the early detection of epidemics, and has proven its worth with diseases like Malaria, Influenza, and Covid-19 (Kuhn et al., 2005).

An early prediction of infectious disease incidence can be used for the design of emergency response management systems, that enhance the mitigation, resource allocation, preparation, and responsiveness of an outbreak (Mukhopadhyay et al., 2022, Brett et al., 2017). Additionally, through effective communication of prevention and awareness campaigns, an engagement with communities and actors can be created, leading to a quick response.

Goals and Methods

This project takes off where previous publications and related works on climate change and tick-borne diseases stopped. In order to analyze the effect of climate change on the incidence of Lyme borreliosis, it is of interest to be able to forecast future incidences.

The predictions are estimated based on historical data from the Deutscher Wetterdienst and the Robert Koch Institut from 2016 to 2022 in Bavaria, Germany. The covariates used in the model are temperature and precipitation. A first approach also included sunshine duration as an exogenous variable which was later omitted due to the strong correlation with temperature.

Two predictive models using statistical regression methods were deployed in Python, testing an ARIMA and a Seasonal Decomposition of Time Series (STL) with exogenous variables. The available data was split into training and test data, which resulted in both models using the data from 2016 to 2020 for training and the data from 2021 and 2023 for testing. After comparing these two models based on the accuracy and plausibility of the predicted results on the test data, the choice was made to use the ARIMA.

The ARIMA model is a statistical analysis model that utilizes time series data to predict future trends and is particularly common in economics, weather forecasting, and capacity planning. This means it allows the dependent variable to be influenced not only by current values of the independent variables but also by the past values of the independent variables and possibly by its past values. The ARIMA model can be divided into three main components. As an

autoregressive model, the evolving variable of interest is regressed on its own lagged values. The integrated component refers to the replacement of the actual data values by the difference between their values and the previous values.

The moving average as a third component of the model incorporates the dependency between an observation and a residual error from a moving average model applied to lagged observations (Hayes, n.d.).

Mathematically, a time series $\{x_t; t = 0, +/-1, +/-2, \ldots\}$ is ARMA (*p, q*) if it is stationary and

$$xt = \varphi_1 x_{t-1} + \ldots + \varphi_p x_t\text{-}p + w_t + \theta_1 w_{t-1} + \ldots + \theta_q w_{t-q} \quad \text{Eq.1}$$

with $\varphi_p \neq 0$, $\theta_1 \neq 0$, and $\sigma^2_w > 0$ and $\{x_t; t = 0, +/-1, +/-2, \ldots\}$ is a Gaussian white noise sequence. The parameters p and q are called the autoregressive and the moving average orders, respectively. A process x_t is said to be ARIMA (*p, d, q*) if is ARMA (*p, q*) (Shumway et. al., 2017).

$$\nabla^d x_\Delta = (1\text{-}B)^d x_t \quad \text{Eq. 2}$$

We fitted an ARIMA (1,0,1) model. This means that the autoregressive order is 1, indicating that the current value of the time series is dependent on the previous value. With an integration order of 0 no differencing is applied to time series and a moving average order of 1 indicates that the error term of the model is dependent on the previous error term.

Outcome and Discussion

Overall, we can observe that there is a strong correlation between the input factors of our model, namely temperature, precipitation and sunshine duration, and the incidence of Lyme borreliosis.

Temperature significantly impacts disease incidence, as shown by a Pearson correlation coefficient of 0.82 (Figure 3, top left panel). Similarly, sunshine duration has a moderate correlation with incidence rates, indicated by a correlation coefficient of 0.63 (Figure 3, top center panel). In contrast, precipitation shows a slightly weaker correlation of 0.39 with incidence rates (Figure 3, top right panel). Additionally, the lower panels of Figure 3 demonstrate the interdependencies among climate factors: there is a strong correlation between sunshine duration and temperature (correlation

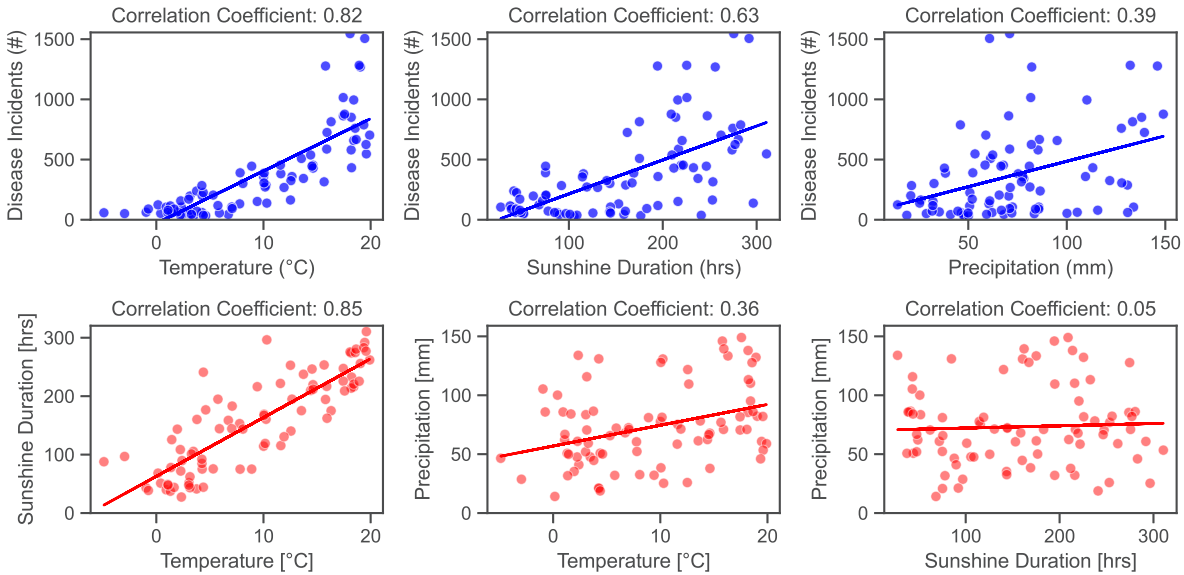


Figure 3: Correlation studies of different climate factors with disease incidence

coefficient: 0.85, bottom left panel), suggesting that these factors do not vary independently. In contrast, precipitation is relatively independent from the other factors (correlation coefficients: 0.36 with temperature and 0.05 with sunshine duration, bottom center and right panels respectively). The near-zero correlation between precipitation and sunshine duration (Figure 3, bottom right panel) is illustrated with a linear fit, highlighting the lack of any significant positive or negative relationship. Based on these findings, in our model, precipitation and temperature are assigned higher weights to avoid redundancy and overemphasis on correlated variables like sunshine duration, ensuring a balanced and robust analysis.

For our predictions, we forecasted the incidence of Lyme borreliosis in four different greenhouse gas emission scenarios, also known as Shared Socioeconomic Pathways (SSCs), as released in the U.N. climate panel report released on August 9, 2021, according to which climate factors will change in different ways.

In SSP1-2.6 global CO_2 emissions are cut drastically, and net-zero will be reached after 2050 resulting in stabilized temperatures around 1.8 °C higher by the end of the century. The second scenario, SSP-4.5, is a "middle of the road" scenario. While CO_2 emissions will start to fall in the middle of the century, net zero will only be achieved after 2100 and temperatures will rise by 2.6 °C by the end of the century.

The SSP3-7.0 scenario assumes that CO_2 emissions will roughly double from current levels by 2100 with an average temperature rise of 3.6 °C by the end of the century. The last and most dangerous scenario presumes a doubling of CO_2 emissions by 2050 and by 4.4 °C higher average global temperatures by 2100 (Anthesis-Climate Neutral Group).

According to the Intergovernmental Panel on Climate Change, the current climate protection targets that governments around the world have set themselves could result in a warming of 2.8 °C by 2100, which would be between scenarios two and three, namely SSP2-4.5 and SSP3-7.0.

Our predictions indicate that in the most lenient scenario, SSP1-2.6, the incidence of LB will hardly increase over the next decades with almost no incidence in the winter months and roughly 960 cases in the peak season in summer in all of Bavaria as shown in Figure 4. On the other hand, in the most severe scenario of an increase of global average temperatures by 4.4 °C by the end of the century, the incidence will rise significantly by 2100. Even in winter months, which are nowadays characterized by very few to no infections, the incidence will have risen to 117 and to more than 1000 in the summer months. This is an increase of 4% compared to the most optimistic greenhouse gas emission scenario. As experts assume a temperature rise of 2.8 °C, we can forecast an incidence between 1088 and 1151 during the peak tick season and 189 and 232 during the off-season, which indicates an increase between 5% and 22% to current levels. Figure 5 further illustrates the temporal change in lower/upper bounds of predicted incidence rates for different SSPs. These projections underscore the critical importance of considering various scenarios in planning and response strategies to mitigate potential health impacts.

However, the relationship between the tick population and the incidence of infection is complex, with many different variables interacting and influencing each other in parallel. Microclimatic variables such as soil surface temperature and relative humidity (which are affected by things such as slope and aspect, snow cover, vegetation, litter layer, humus, and underlying soils) can be critical in determining the distribution pattern of specific niches for tick survival within an area (Vermont Department of Health, 2018; Gray et al., 2008).

The influence of tick-borne diseases may be influenced by socioeconomic factors, human migration and settlement, ecosystems, and biodiversity, migrating patterns of birds, land-use and land cover changes, human cultural and behavioral patterns and immunity in the population.

Nevertheless, this study has shown the strong correlation between climatic factors and the incidence of infectious diseases. While Lyme borreliosis and ticks will most likely not be the topic with the highest priority when thinking of climate change and its effects, it still shows that these two topics are intertwined. Combatting climate change also helps in the dimension of health and the prevention of the spread of diseases.

Summary and Future Goals

This research project was initiated to explore the epidemiological impact of climate change on the incidence of Lyme borreliosis in

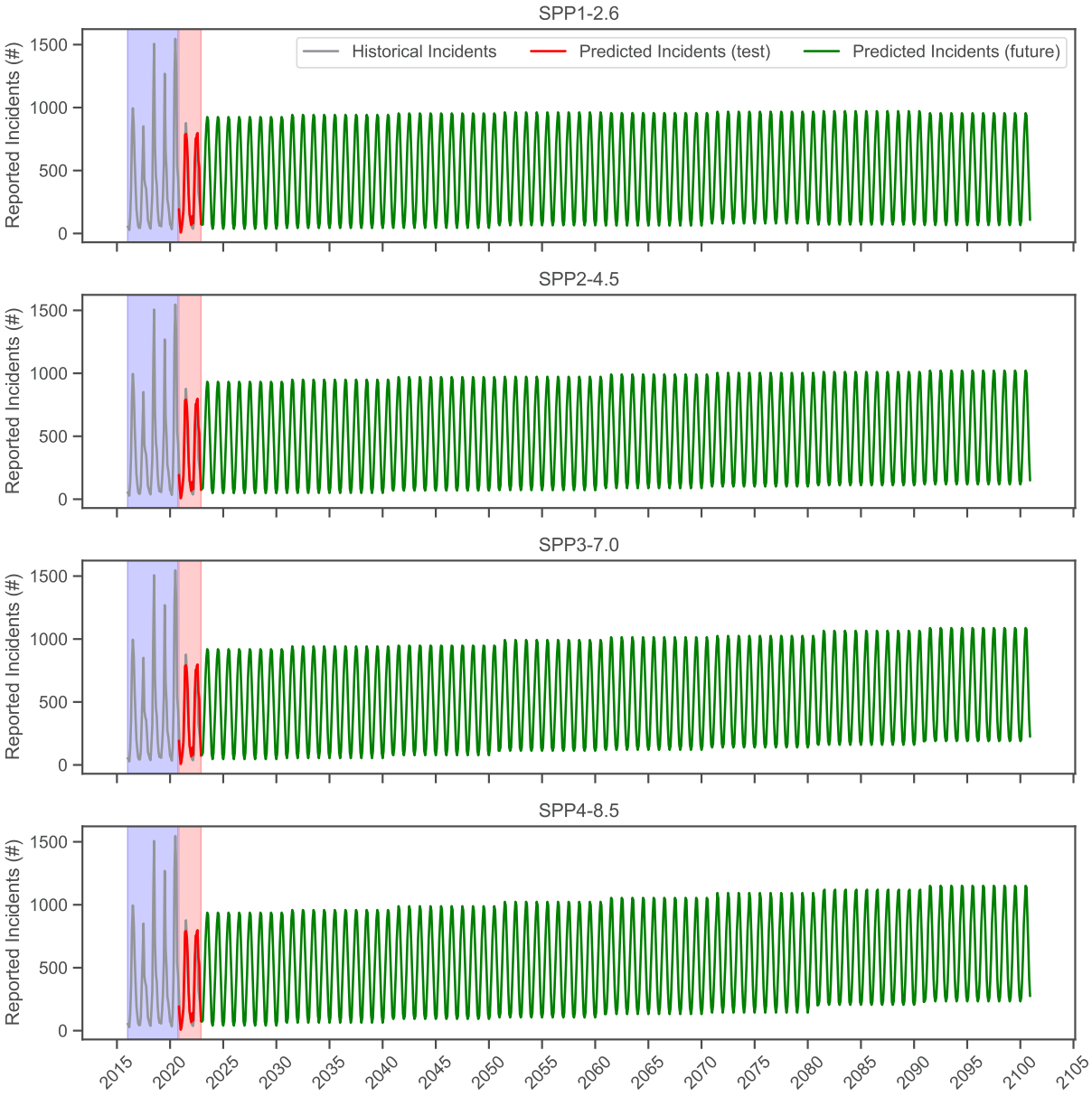


Figure 4: Predicted incidence rates for different SSPs.

Bavaria, aiming to bridge the gap in awareness and understanding of this emerging disease in Europe. Utilizing local data, we developed a predictive model to estimate the prevalence of LB from 2023 to 2100 under varying greenhouse gas emission scenarios.

Our findings indicate a direct correlation between the rise in greenhouse gas emissions and the incidence of Lyme borreliosis. In the most severe emission scenario, the incidence is projected to increase substantially, highlighting a critical window of risk and epidemiological severity. Conversely, in scenarios where global efforts successfully reduce emissions, the increase in LB cases is expected to be marginal. However, the complexity of the disease dynamics, influenced by factors such as host populations and human behavior, poses challenges to the predictive accuracy of our model. Data limitations, particularly the lack of detailed predictive land use data, further restricted the depth of our analysis.

To refine and expand our understanding, future research should focus on collecting more data from regions beyond Bavaria, conducting comparative studies with tick-borne encephalitis and other tick-borne diseases, integrating more detailed parameters to examine interaction effects more comprehensively, evaluating the potential impact of a Lyme borreliosis vaccine on disease incidence, and launching an awareness campaign informed by our findings, in collaboration with public health stakeholders.

These efforts will enhance our model's accuracy and deepen our understanding of disease dynamics. Additionally, they will help translate complex scientific findings into actionable information for the public, aiding in the development of effective preventive strategies.

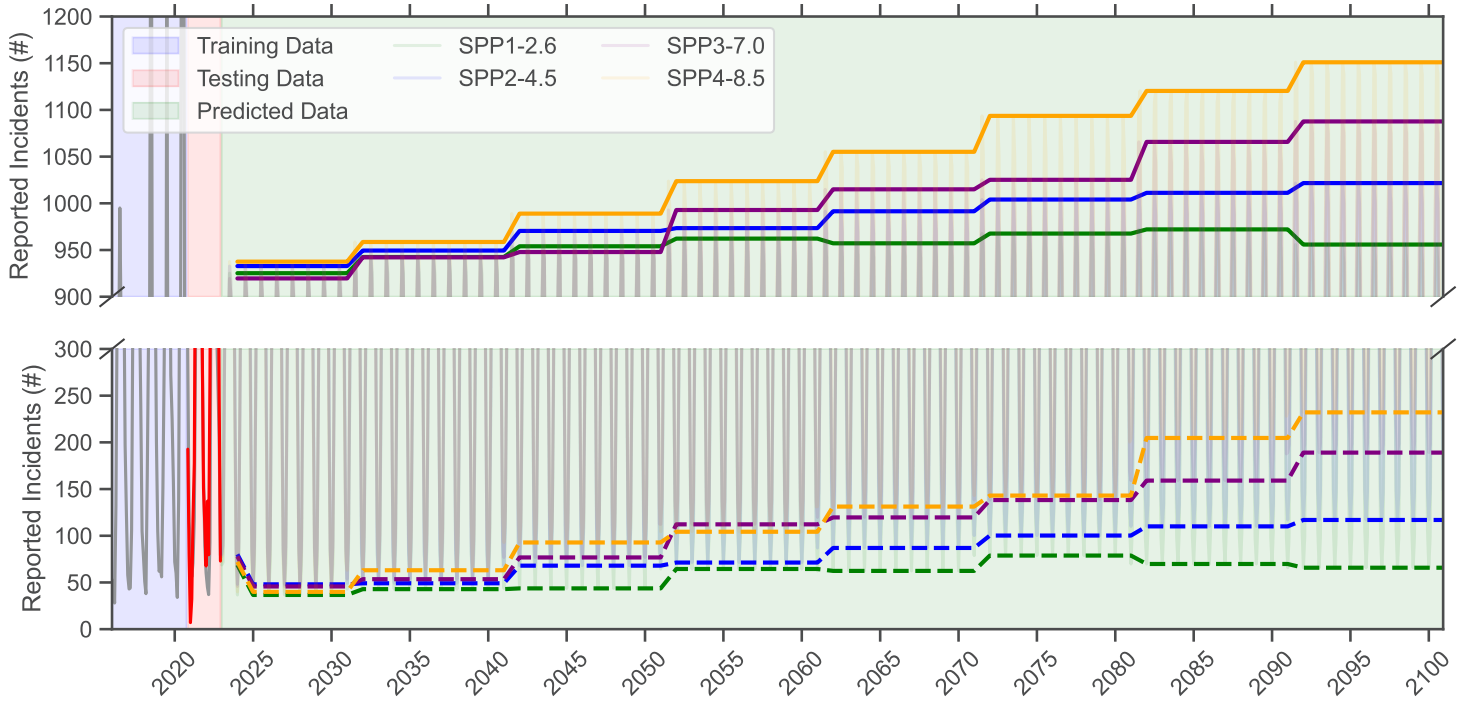


Figure 5: Temporal change in lower/upper bound of predicted incidence rates for different SSPs.

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Self-reflection

Our Team Tick Talkers is an interdisciplinary team of six students whose motivation united us in developing a project related to climate change and medicine. We started with the general idea of analyzing how climate change could affect our health. Our first thought was to focus on vector-borne diseases such as Dengue Fever or Malaria, as this first idea came up during a brainstorming session when we briefly mentioned that we didn't expect to have so many mosquitos, as it was late November, but it was relatively warm, so they were still around.

After a research phase considering data availability and weather relations of infectious diseases and other pathologies such as cardiovascular or respiratory diseases, we eventually decided to look at tick-borne diseases, as they are already prevalent in Germany.

After taking this decision on tick-borne disease, discussions moved on to the different use cases and the target audience for our project. As the call of our class is "Less is More: Empowering individuals to focus on the essentials," the first idea was to use our project as a tool to improve logistics and the distribution of medical resources to reduce medical waste and combat shortages of medical supply.

During the TUMJA seminars, we received feedback that helped us to narrow down the scope of our project and determine specific goals and milestones, which resulted in a more clearly defined project, namely to develop a predictive model for the incidence of Lyme Borreliosis in Bavaria up to 2100 based on temperature and precipitation.

The result was the objective to deliver a model that is accessible to the general public on a user-friendly website. The prototype of the website also provides general information about ticks, such as what they are, their life cycle, how to remove ticks, the disease itself, and general recommendations. As the idea of correlating weather data with disease incidence derived from a discussion within the context of climate change, the model includes predictions with different greenhouse gas emission scenarios. The goal is to evidence some of the not-so-obvious effects that climate change can have on different aspects of life.

After having decided on the predictive model as a more concrete project, we divided our team into a research team and a modeling team. While the research team focused on the theoretical backgrounds of the disease and the vector, as well as ticks' life cycles, the modeling team collected all the data and implemented the model.

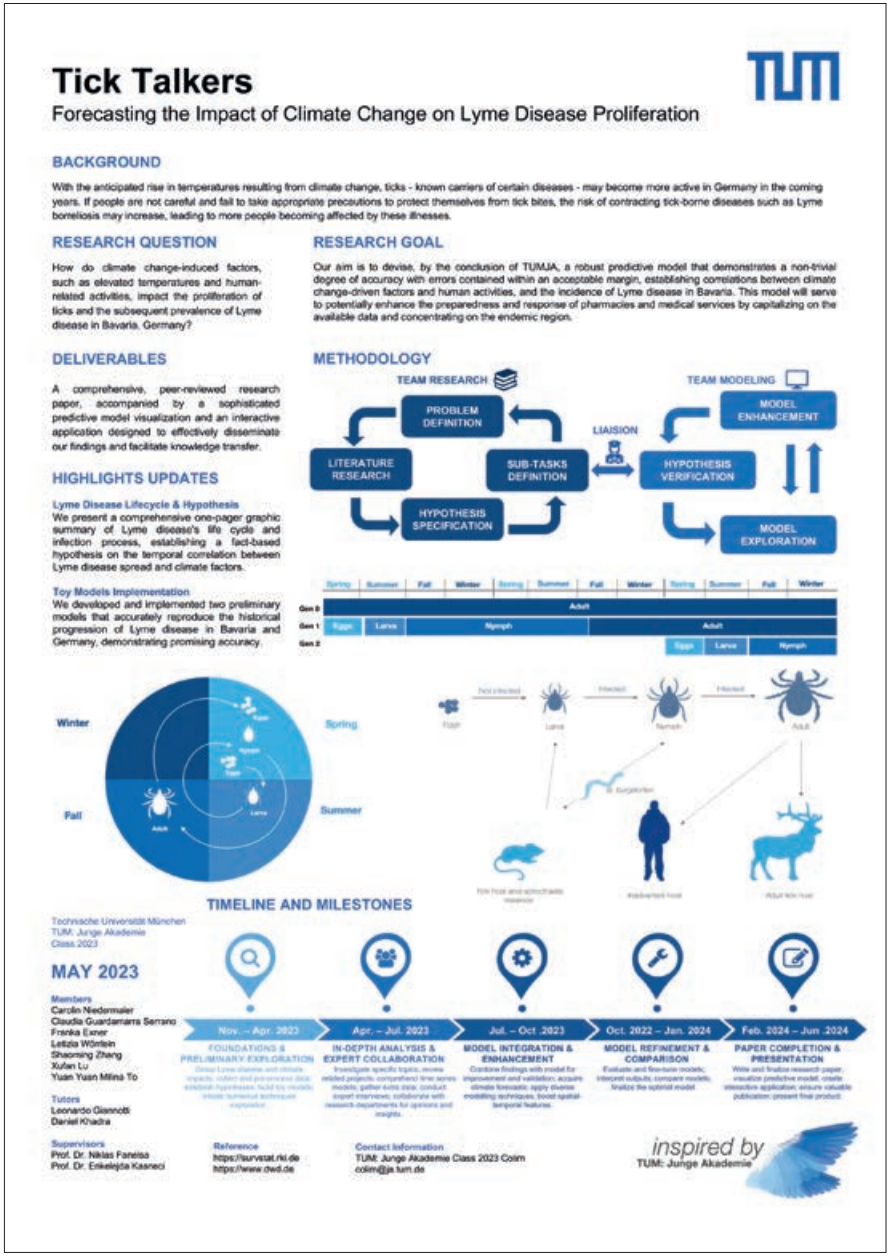
Overall, the Tick Talkers project was a valuable learning experience for all team members. However, one of our main challenges, mostly at the beginning of our project phase, was the coordination of the work, especially when team members were abroad or had other commitments, which sometimes led to a delay in our schedule. We all felt that a stronger push from the official TUMJA body to deliver not just posters but actual content a bit earlier throughout our time, along with shortening the sessions at the seminar weekends to leave more time for group work within the teams, would have helped us to implement further features into our project and advance more quickly.

We developed both hard and soft skills, ranging from academic and journalistic writing, coding, implementing a statistical model and data analysis, to teamwork, communication, and problem solving, which will be useful to all of us in our future endeavors. Furthermore, we learned how to overcome challenges and adapt to changing circumstances. Lively discussions, and scaling big ideas down to a project that is implementable in the setting of TUMJA, especially with all the other projects and deadlines everyone in our team had going on at the same time, are valuable key learnings.

In addition, we are deeply thankful for the professional support from our supervisors, Prof. Dr. Enkelejda Kasneci and Prof. Niklas Fanelsa. While they gave us lots of freedom in our project, the regular meetings pushed us to make progress in our project. Moreover, they often came up with concepts to visualize our findings and supported us with helpful material and ideas. We are especially thankful for the contact with Yao Rong, who works with Prof. Dr. Kasneci in the Human-Centered Technologies for Learning group. Her input and ideas on how to create visibility for our project and make an impact were very exciting and she put a lot of work and time into helping us wherever she could.

Furthermore, we had the pleasure of exchanging ideas with Dr. Merle Böhmer and her team from the Bayerisches Landesamt für Gesundheit und Lebensmittelsicherheit. Working in the Department of Infectious Disease Epidemiology and especially on tick-borne diseases, namely tick-borne encephalitis, she gave us valuable insights into her research and her interest in our project boosted our motivation.

In conclusion, we all learned a lot at TUMJA working on the Tick Talkers project and enjoyed our time, although we have some suggestions for improvement to help future scholarship holders profit even more from TUMJA. ■



POSTER 1:

During the first few months of our time at TUMJA, we participated in workshops to help us define our project. We came up with the idea of a topic related to climate change and the spread of a disease. After several discussions about more 'exotic' diseases such as dengue fever or malaria, we finally decided on Lyme borreliosis as it is already more present in Germany and therefore more relevant and tangible for the general public. Initially, we wanted to improve supply chains in the medical sector. We wanted to be able to predict the incidence of Lyme borreliosis and thus the need for antibiotics. However, we soon realized that this was a complex process and shifted our focus to informing the general public.

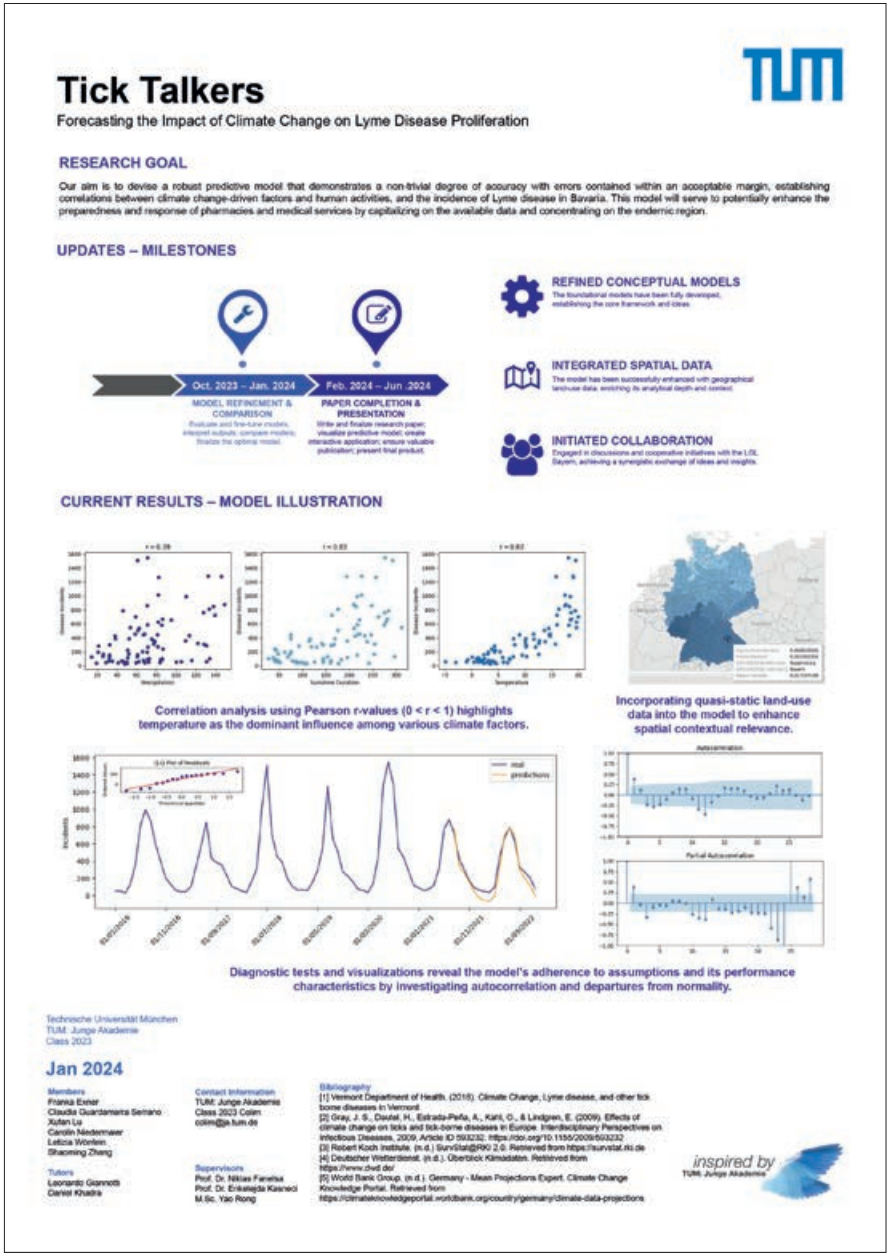
After deciding on our topic and goal, we spent the first few months researching the life cycle and reproductive behavior of ticks and the transmission process of Lyme disease from an infected tick to a human.

POSTER 2:

To create our model, we identified the following inputs: temperature, humidity, land use, host density and human population. With these, we want to predict the incidence of Lyme borreliosis in Bavaria. We grouped the inputs into different categories in order to implement a multimodal model.

We also created the first graphical representation of the website we planned to build. We wanted to show the risk areas for Lyme borreliosis on an interactive map, where users could choose which greenhouse gas emission scenario and which 10-year time frame they were interested in.

At the same time, we also looked at which scientific journals we could use to publish our final paper. After analyzing several papers and searching various websites about ticks and the impact of climate change on tick-borne diseases, we were able to identify the research gap that our project would fill. We found that no predictive and regional model has been developed yet and that our model can add significant value..

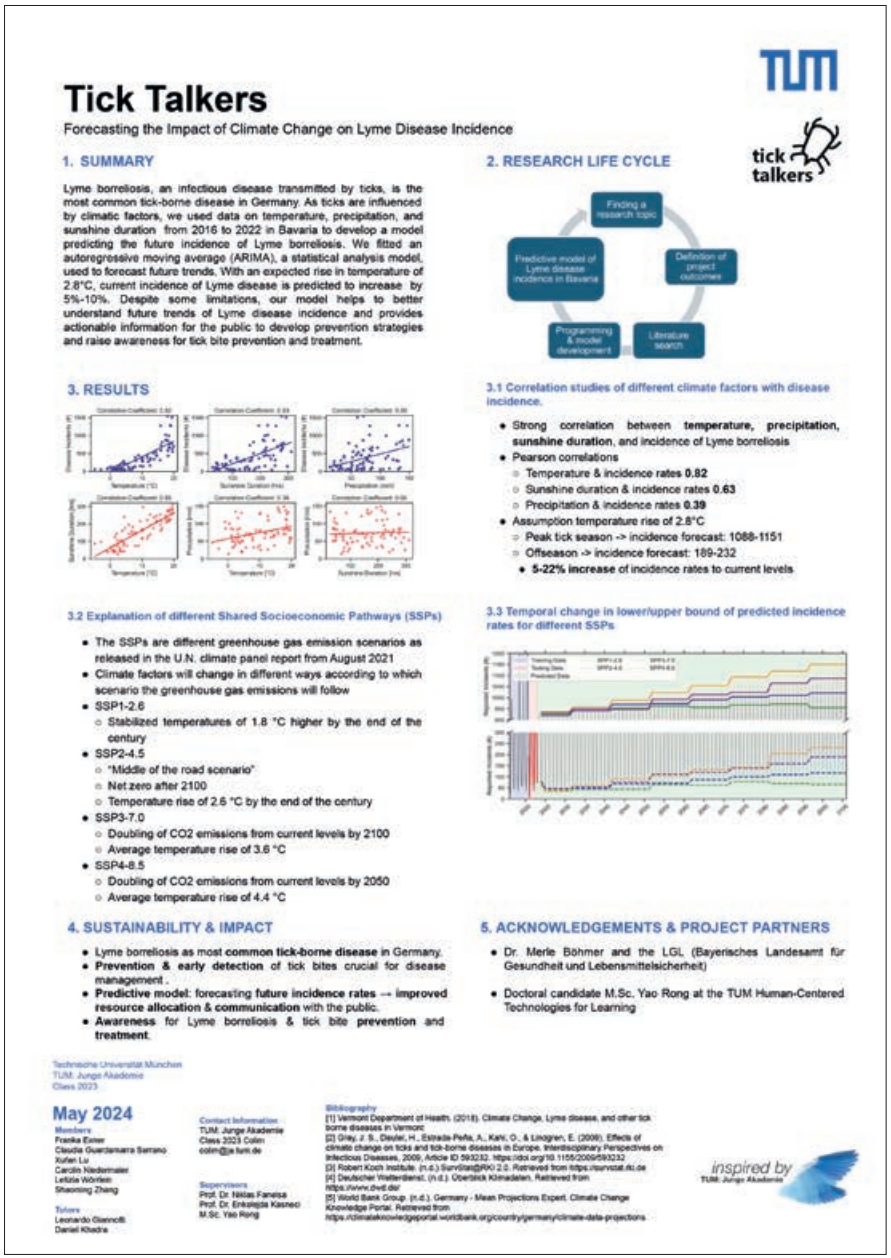


POSTER 3:

The correlation of the following variables with the incidence of Lyme borreliosis was evaluated: precipitation, sunshine duration, and temperature. We concluded that a strong correlation of the incidence with all three factors, and especially temperature, seems to have a high influence on the spread of Lyme borreliosis and implemented the first two models. Since the Q-Q plot of residuals indicated that the data is normally distributed, we decided to use advanced linear regression models such as ARIMA to implement two toy models.

Even though we had identified land-use data as a possible input variable and saw that with quasi-static land-use data, our model would better capture the spatial dynamics of Lyme disease, as reflected in the autocorrelation analysis, we eventually decided not to utilize it in the model. This was because land usage is a variable that only marginally changes in shorter time frames and we weren't able to find predictive land use data. Furthermore, we encountered some difficulties mapping the land use to each Landkreis, which is the basis for the incidence data. Therefore, we decided to use the land use data only as an additive piece of information on the website, as displayed on the prototype of the interactive map, which was built using Tableau.

We also started a collaboration with the LGL (Bayerisches Landesamt für Gesundheit und Lebensmittelsicherheit) to widen the impact on the target population and gain a better insight into the topic.



POSTER 4:

The emphasis was on cleaning the prediction data and implementing the predictive part of our model. We first encountered some unexpected results but soon found the mistake in our code. As the effect of climate change and the impact and differences between the four different greenhouse gas emission scenarios were more strongly visible in the second half of the twenty-first century, we decided to show the prediction of all four scenarios up until 2100 instead of only 2050. We did see a strong increase in the incidence of Lyme borreliosis in the next decades, especially in the SPF-8.5 scenario.

At the same time, we began writing our journalistic and scientific reports. Team research progressed quickly and with Mr. Fromm's feedback, we were able to adapt our style and content to produce an interesting news article.

During the final part of the project, we continued to write the paper, which we expect to publish in the autumn, after our official TUMJA time. We also developed the video presentation for the symposium and finished writing the various sections of the research report required by the official TUMJA body. ■

Research Report **TUMANYwords**

We from TUMANYwords have the goal to make the application process at TUM easier to follow and used the bachelor program Mathematics as a case study. During our time at TUMJA, we developed a mock-up website featuring content personalization, simplified language and transparent navigation that directly leads applicants to the documents and deadlines relevant for their application. We also compared the website to the current TUM application information site in a two-stage usability test with schools in Germany and Brazil

Team	Euridice Pinheiro Vieira Harke Veronika Hofmann Inés Velasco Martínez Peter Ridilla Ziwei Wang
Tutors	Bernhard Häfner Sebastian Zäpfel
Supervisors	Prof. Dr. Sylvia Rothe Prof. Dr. Claudia Küppelberg

Preface by the Supervisors

Prof. Dr. Claudia Klüppelberg und Prof. Dr. Sylvia Rothe

Prof. Dr. Claudia Klüppelberg

Prof. Dr. Sylvia Rothe

Everybody has to enter information into web pages nowadays and occasionally puzzles over explanations on such websites, which are often convoluted and opaque, giving us a difficult task. Our group TUMANYwords had the ambition of improving communication on web pages, and took as their leading example a TUM admissions web page used by pupils around the world to gain admission to one of the TUM study programs. The focus was on the web page providing information in such an application process. The group members adopted methods like content personalization, simplified language, and more transparent navigation to design a new web page. Throughout the project, the team took innovative approaches and integrated simplifications in layout and language and clearer navigation into the redesign of the TUM admissions website. Their efforts were validated through usability testing that showed improvements in user experience. In order to compare the usability of old and new web pages, they assessed the quality of both old and new web pages by empirical usability tests. The group succeeded in a demanding project of interdisciplinary research.

Beyond the technical achievements, what stood out most was the spirit of cooperation and the sharing of a common goal within the group. Despite different backgrounds and skills, they were united by that common goal, which led to valuable project results.

As supervisors, we had the privilege of observing a group of young students developing from highly motivated singletons in different study programs into a joint research group, whose interdisciplinary members brought together their diverse personalities and disciplinary strengths to successfully conclude a unique and socially important project within the given deadline. Each member brought unique perspectives and expertise to address the challenges of web communications. We hope that the result of the project will serve the TUM admissions process and many other web-based processes in the future.

Today's Special Offer: No More Confusing Application Processes!

It's way past midnight, Paul is still at his desk with confusion written all over his face and his hands shaking – the deadline is near! … Does this sound familiar to you?

Paul is just a fictional character representing all the soon-to-be university students helplessly facing an application deadline that is dawning, like a little dream that is going to be shattered by the alarm clock. Going astray in this nightly fog full of links and information with no light within reach, this one piece of information that is still missing. A never-ending labyrinth. And what's that? A jack o'lantern!

"TUMANYwords […] created a remedy for every application-related headache."

A situation familiar to every student at TUM, especially when coming from abroad. The website is designed beautifully, shimmering in a deep TUM blue like a venomous snake. Information over information but where is the structure or the comprehensible language?

Almost 10 tabs are needed to find all the relevant information when you have a German "Abitur" and probably even more if you have a different university entrance qualification.

But does applying for university need to be this complicated just because it has always been this way? No, says TUMANYwords.

Team TUMANYwords from the scholarship program TUM: Junge Akademie created a remedy for every application-related headache. An app that contains every piece of information needed for an application, explanations for every word that is difficult to understand and more importantly a simple structure and language so only one tab is needed. Like Ariadne's red thread that saved Theseus after killing the Minotaur, this app leads every lost applicant back on track to their happy ending. Or to put it in a more understandable way: It's like the app "Akinator" that guesses what you are thinking: It asks you a question, you answer it truthfully with "yes" or "no" and it tells you what you need for a successful application. Quick, clear, understandable and without any hidden agenda. Tested with and approved by pupils in German Schools from both Brazil and Munich.

An international study from TUMANYwords has shown that using the app reduces, by more than half, the time needed to find the right information relating to the key data, and it also reduces wrong answers by half.

The only unfortunate thing? Right now, this stroke of genius is only available for the study course B.Sc. mathematics. But, in collaboration with TUM, it will surely develop into a groundbreakingly time-saving device for future students.

On a side note: while writing this feature, I was looking for a positive word to describe the TUM website for a comparison, so I asked the person next to me which word he would use. Quick like a shot it came: "Confusing!" After a dizzying train of thought, it ended up being "TUM blue."

TUM – but how to get in?

Research Report – TUMANYwords

Applying to the Technical University of Munich (TUM) presents challenges for many students and particularly those with foreign university degrees, who might find it time-consuming to locate and understand information on TUM's various websites.

In this study, we developed and tested a proposal to improve the clarity of information conveyed through the website designated for applications to the B.Sc Mathematics program. We designed a self-assembled mock-up website to determine whether structural alterations and information displayed in simple language could enhance the process of gathering information for the aforementioned application.

In order to assess the efficacy of the old website versus our new model, we carried out a quantitative study that measured performance – indicated by time taken, tabs opened, success rates - as well as user experience and language comprehension via usability questionnaires. Our participant pool consisted of 11th and 12th grade students with varying levels of German proficiency from Brazil and Germany.

Findings indicated that the existing website layout made finalizing a correct application challenging and often leads to misinterpretations of requirements. Our mock-up website, on the other hand, enhanced the speed of completing a simulated application at TUM and received higher user experience scores (UEQ). Also, we found no correlation between German language proficiency and performance.

These results highlight the necessity of a comprehensive structured content display on informational websites. They also emphasize the need for a balance between condensing information and oversimplifying it, to achieve optimal user understanding.

Moving forward, our mock-up website presents a more user-friendly and efficient alternative to the current website for prospective TUM students.

Background

Presenting written information in a convoluted, unclear way makes it more likely that the information will be misunderstood, in contrast to communicating in a simple, straight-forward manner (*Labrador Reveals the Effectiveness of Plain Language Proven by Data, 2020*). The means of conveying information determines whether it will reach the whole target audience or just a fraction of it (Langford et al., 2021). While one can observe this phenomenon in every aspect of daily life, it particularly occurs in universities, where complicated sentences and long reference chains are used constantly (Clayton, 2015). Here, not only the contents of the study programs are difficult for many students to understand, but also the application processes that enable them to enroll in the first place.

While it is clear that application processes require a certain complexity to cover all necessary proofs of qualification, it is not essential that the information about the process has to be delivered complexly as well. Applicants who are patient enough to thoroughly gather all of the information on this process are not necessarily the best fit for their study program, and applicants that get easily frustrated by websites are not necessarily bad students.

One of many examples of a website providing information on a university application process which is rather difficult to understand, is the website on TUM's bachelor program Mathematics. The way in which information is presented here is at least partially imprecise, incomplete and not clearly structured.

In this study, we develop and test a proposal to improve information conveyance using the mentioned website as an example.

The methods for improving the website comprise content personalization (Tam, 2006), the use of simplified language (Hinchliffe & Mummery, 2008) as well as a more transparent navigation (Zhang & Yang, 2009). These principles have been shown to increase user satisfaction in other contexts, hence it is expected that they improve user experience here as well. Together with the results of a

small-scale qualitative assessment of the current website regarding users' performance, language comprehension and experience, these methods are the cornerstones of the mock-up website, which we developed as an alternative to the current website.

The method we use for the assessment of the websites is usability testing. Website usability tests have their origin in health sciences, where the importance of understandable websites is clear. The aforementioned characteristics (performance, language comprehension and experience) were proposed by Anetta Hincliffe and William Mummery, who improved a physical activity health promotion website using a self-designed test, which captures the users' impressions on the website's design, navigation and terminology. By "performance" Hinchliffe and Mummery mean the time needed for a task, or for the whole test, as well as the number of errors made. "Language comprehension" describes the ability of the participants to understand the information in a way that allows them to answer questions about it (TUM language optimization expert Julia Pötzl advised our design of a comprehensibility questionnaire). "Experience" refers to the subjective user experience, which is evaluated with two methods: first, by asking about the difficulty of the just-finished task after each task, i.e. using the so-called "single ease question." The difficulty is evaluated on a 7-point Likert scale ranging from 1 (very difficult) to 7 (very easy). This type of scale is highly correlated with other measures of user experience and is an established tool in website and product testing (Sauro & Dumas, 2009). The second measure of user experience is the so-called User Experience Questionnaire (UEQ), a widely recognized tool for the assessment of several characteristics in user experience: attractiveness, efficiency, perspicuity, dependability, stimulation and novelty (Laugwitz et al., 2008). These categories are explained as follows:

- Attractiveness: is your experience with the website enjoyable, good, pleasing? Does it send out a friendly vibe?
- Efficiency: do you feel fast, efficient using the website? Is it organized, practical?
- Perspicuity: is the structure and text on the website understandable, clear, easy to learn?
- Dependability: is the website's reaction predictable, does it meet your expectations? Does it feel secure to use the website?
- Stimulation: does using the website feel exciting, motivating, interesting?
- Novelty: does the design and structure of the website feel creative, inventive, leading edge?

The participants of the usability tests should at least partially represent the demographic of users of the application information website. The typical applicant for a bachelor's degree in Mathematics at TUM is a high school student either in their last year of school or having recently completed it, and with a likelihood of 42% that they did not go to school in Germany. The five most prominent countries of origin of foreign TUM students are China, India, Turkey, Austria and Italy (*TUM in Zahlen 2020, 2021*). When widening the context to all German universities, with a probability of 16% the potential applicant has a study-relevant disability (*Wissenswertes Rund Um Das Studium Mit Behinderung Und Chronischer Erkrankung, n.d.*).

Eventually, we use the testing methods to answer the question of whether structural changes and language simplifications can improve the information-seeking process in the application for the TUM bachelor's program in Mathematics.

Goals & Methods

This section explains the choice of study participants as well as the testing procedure.

Participants

The testing consists of two rounds, the pre-tests and the comparative tests. As mentioned in the introduction, the most important target group of the website are high-school students in their last year who attend school in Germany, China, India, Turkey, Austria or Italy.

For usability pre-tests, China and Italy are of particular interest since these countries require additional documents and details about these are not easy to find on the TUM website.

Performing the pre-tests in Munich, age and education are the easier criteria from this list. However, we are unable to find willing participants from the last (12th) year of high school due to a clash with their Abitur exams, hence we recruit students from the second-to-last (11th) year of high school, assuming that their ability to find written information on a website would not differ too much from their one-year older colleagues. This of course implies that these students attend school in Germany, not in China or Italy. To also gather information on the experiences of those demographics, some of the participants receive instructions to search for information that is relevant for an applicant who completed high school in one of these countries. One of the participants was diagnosed with a learning disability, making it possible to cover this perspective at least to some extent in the pre-tests.

Eventually, we invited six participants to the TUMJA office to complete the tasks of the usability pre-testing round.

After finishing the development of the mock-up website using the results from these first tests, the second round of Usability Testing starts. This second round involves more participants and is of a quantitative nature, helping us to spot the statistical differences between the old and the new website. We group the participants into one group working with the new website and a control group working with the old one. All 76 participants are in 11th grade of high school, 69 of them attend a German school in Brazil, 6 go to school in Germany. A large number of the Brazilian participants are non-native German speakers.

Study Design

While we use the testing guidelines by Hinchliffe and Mummery as an orientation, our methodology differs at several points. Hinchliffe and Mummery have two rounds of Usability Testing, where the only changing variable is the website. They use the results of the first round to improve the website, and then test for significant differences in the second round with the improved version. The number and demographics of the participants is similar for both rounds. Due to logistical constraints, we decide to split the two rounds differently.

Our first round is a purely qualitative test using only the old website, with a small sample and a broad demographic. The idea behind this is to gather insights into the information-finding process from several different backgrounds and for as many aspects of the website as possible. Since this is a considerable effort for the participants, as it requires them to work very intensely with the website, we expected that recruitment would not be easy and therefore designed the tests for only a small number of participants.

We printed the tasks on paper. These had to be answered by either collecting information on the website and filling in blanks or selecting multiple-choice options on the task-sheet, or by denoting subjective experiences on the sheet. Also, before the test, we invited the participants to voluntarily declare their German language proficiency and whether they have a diagnosed learning disability. The tasks of the questionnaire included:

1. Simulating the application information finding process by researching the necessary documents for the application and the enrollment, depending on a role the participants were assigned to before the test. This was a person that received their diploma in Germany, Italy or China and has the respective citizenship. There were two participants per role.

2. Describing the application evaluation process and finding out how to know whether one's application was successful.

3. Researching the maximum number of semesters one's studies are allowed to take.

4. Gathering information about the enrollment and researching the specialties of studying Mathematics at TUM.

5. Filling out a standardized questionnaire on user experience.

We gave the tasks to the participants in the form of a multipage paper. The participants brought their own computers to perform the research.

In accordance with the test by Hinchliffe and Mummery, the pre-tests measure the three characteristics: performance, language comprehension, and user experience. We measured the performance by recording the time for task 1 and evaluating whether the students selected correct documents, deadlines and submission forms. A correct answer yields +1 point, a wrong answer -1 point, and no answer 0 points. Also, we evaluated the answers of tasks 2

and 3 for performance measure. We evaluated language comprehension with task 4. Task 5 generated data on the user experience. We analyzed the results of the pre-tests to find out about the most outstanding issues with the old website so that the new website can be developed targeting precisely these problems.

As soon as we finished the mock-up, the second round of usability tests started with substantially more participants. More participants also mean fewer tasks to save time, requiring a new test sheet. However, still the same three characteristics are supposed to be captured: performance, language comprehension and user experience. The test sheet for the comparison tests consists of the following tasks:

1. Simulating the application information finding process by researching the necessary documents for the application alone, without the choice of a role. We asked the participants to perform all tasks using their own (prospective) backgrounds as high school alumni.

2. Gathering information about the enrollment, describing the application evaluation process and finding out how to know whether one's application was successful.

3. Filling out the User Experience Questionnaire (UEQ).

The participants measured the time to complete tasks 1 and 2 respectively by themselves. Also, we asked them to denote the number of browser tabs which they needed to open for the research. This number is of interest as participants of the pre-tests stated that they would have liked it if they had not needed to keep so many tabs open to find all the information.

Fewer tabs means less switching between websites, which provides a feeling of coherence and could help to save time.

As with the pre-tests, we measured performance using the duration of tasks 1 and 2 and by evaluating the answers to task 1. Task 2 aimed at language comprehension, and task 3 provided insight into the students' opinions on the websites. As in the pre-tests, tasks 1 and 2 were followed by the single ease question to collect as many subjective impressions as possible.

We concluded the tests with the UEQ, again as with the pre-tests.

All questionnaires included a comment section at the end, and participants were encouraged to record any thoughts they considered important during the test.

Materials

In the following, we describe the original website and how we constructed the mock-up website.

Status-quo

The main reference point for the testing is the application website of TUM bachelor's program Mathematics as of November 2023. In this section we describe the structure and the content of the website.

The main website consists of four parts - description of the course, information about the application process ("Bewerbung"), information about the admission process ("Einschreibung") and the course of studies ("Im Studium"). Each section is accompanied by expandable subsections (Fig. 1).

The most relevant information for intending applicants can be found in the section "Bewerbung." Application deadline, required documents and the description of the application process can be found here. There are also subsections explaining two important aspects of the application process - letter of motivation and essay.

The information stated in this section is, however, imprecise, incomplete and not properly structured.

One example of imprecision is in the language requirements. The subsection "Was muss ich beachten, wenn ich aus dem Ausland komme" ("What do I have to consider if I come from abroad") states all applicants are "usually" ("in der Regel") required to submit a sufficient proof of language proficiency if their classroom language was not German. This is specified only in the corresponding statute (*Satzung über Das Studienorientierungsverfahren Für Den Bachelorstudiengang Mathematik an der Technischen Universität München, 2018*), which for example excludes German nationals who attended a German-speaking high school for less than two years and do not have German Abitur.

Additionally, this statute is linked in the website under the section about the course of studies, subsection examination regulations. Both the section and the subsection are not directly related to the application process.

Subsection “Was muss ich beachten, wenn ich aus dem Ausland komme” also contains information about German nationals whose classroom language was not German. This is also relevant to some German nationals born and living in Germany, despite the title suggesting otherwise.

In the subsection regarding the required documents, some documents are listed as relevant in some cases (“ggf.”). These are mostly required for international students. This, however, is not stated anywhere in the subsection. German nationals might find the information irrelevant or even confusing, as they have to make sure they do not need to get some of the documents. On the other hand, some international students might find the information also confusing as not all documents are listed here. This is the case for students from countries such as China, Vietnam or Georgia, where the applicants have to meet special criteria. All international students are guided to a link below the list to find out if and which special criteria might apply in their case.

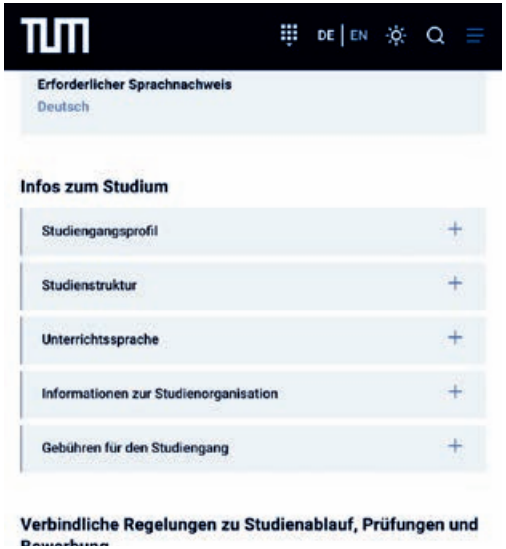


Fig. 1: Status quo website for TUM B. Sc. Mathematics applicants

Mock-Up

As a part of the research question, we provide an alternative information website where students can get information about their desired study course. For the model we again choose the TUM bachelor’s program in Mathematics.

To create an alternative model, we had to consider two strong constraints:

- New model can use only the same content as found on the status-quo website or in the attached or publicly accessible documents.
- The language used in the new model has to be precise.

These constraints ensure that we improve only the model’s structure and wording, not the content itself.

Additionally, there were several principles we followed to improve the current website, mainly:

1. **Use simple language throughout the text wherever possible.** We used a popular large language model GPT3.5 to iteratively simplify the text until we achieved equivalent content in the result. Multiple iterations were often necessary because GPT3.5 has a tendency to leave out important information. In cases where no further simplification was possible, we added additional explanation. GPT3.5 also helped us to identify advanced words such as “Hochschulzugangsberechtigung” (university entrance qualification), which are not easily understandable especially to the international applicants. Some other methods for simplifying the language included using the second person in the text, i.e “du”-form (you-form), and using the active voice (Naji, 2022).
2. **Show relevant information only.** Instead of trying to fit every piece of information in one webpage, we show, step by step, relevant information only. This is important because students have different backgrounds and it’s highly unlikely that each specific group needs to know how the process works for other specific groups, e.g. German nationals will find it irrelevant to know what Chinese nationals are required to submit and vice versa.
3. **Allow simple navigation.** It is reasonable to assume that people need different information throughout their application process instead of having everything at once. We split the information into blocks, where more details are shown on request. It is

important to note this principle is already partially present on the status-quo website.

4. **All information in one system.** There should be no need to search for information outside one system regarding the application process.

Design and user Journey

We demonstrate the principles on a model of a web application. After opening our web application, the user sees three buttons – *"Important terms"*, which serves as a glossary with additional explanations; *"What do you need for your application?"* with requirements assessment; and *"Key data and contacts"*. The structure ensures we follow principles 3 and 4.

"Important terms" were mostly inspired by the glossary on the status-quo website. The biggest change consists of wording as described in principle 1. We focused on some existing downsides of the status-quo glossary, e.g. missing explanations of some difficult words such as *"Hochschulzugangsberechtigung"* or using multiple terms for the same concept, e.g. *"Einschreibung"* and *"Immatrikulation"* both mean *"Enrollment,"* despite the equivalence not being stressed enough.

"What do you need for your application?" demonstrates principle 2. In this section, the users get multiple questions about their background (Fig. 2) to assess whether and under which circumstances they can study the given course. The output of this section is a list of required documents with their respective forms and deadlines to be submitted (Fig. 3). This eliminates unnecessary information and reduces the need to search for more information for special cases.

As the name suggests, *"Key data and contacts"* provides simple information such as the application deadline, contact partners and the link to the official website.

Technical Implementation

We implement the given design as a Flutter web application. We chose Flutter because it can be used to implement the design and the logic of the application using one codebase. We then uploaded the built website content to our hosting, so it is accessible for the survey participants with ease. The web application did not collect any information, including personal information.

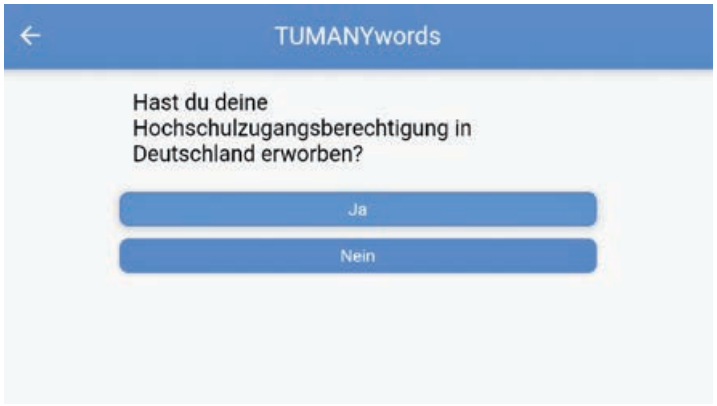


Fig. 2: Mock-up with a question to assess applicant requirements

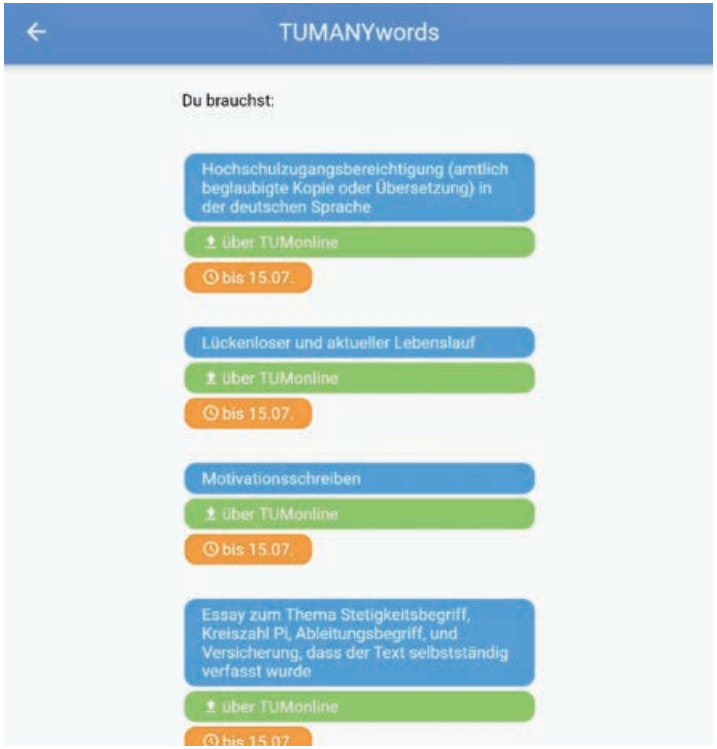


Fig. 3: Mock-up showing personalized requirements

Outcome

We evaluated the pre-tests qualitatively, leading to the following main results: the document search (task 1) took the longest for the students who were assigned the Italian and the Chinese roles. It was rated most difficult by the students with the Italian role, which was also the role with the most errors. For all participants, the choice of language certificates as well as the deadlines were the tasks which yielded the most errors. Even the students who had the role of German citizens with a German high school graduation selected various German language certificates as necessary. The participants performed the other tasks with fewer difficulties. Since task 1 was the largest of all tasks, its difficulty had the largest influence on the UEQ results, which were neutral to negative in all categories. The category with the most extreme negative score was perspicuity. This is not surprising given the results of task 1 and our observations on the status quo. Regarding the comments of the participants, most concerned minor technical difficulties. One comment however noted how it would be nice to have a more interactive website, which returns a custom-made document list.

We used these findings to develop the mock-up, as it is described in the respective section.

We evaluated the comparative tests quantitatively. They reveal significant performance improvements with the mock-up website in both tasks. Using the mock-up, task 1 is completed faster (mean time original website (version A): 36.07 +/- 11.69 min versus mock-up (version B): 18.19 +/- 10.31 min; p-value = 0.00000005) and with fewer errors (mean points version A: 3.43 +/- 3.97 points versus B: 6.69 +/- 5.40 points of a range of -15 to 15 points, p-value = 0.002) than when using the original website. Task 2 is also completed faster (A: 29.20 +/- 14.12 min versus B: 14.18 +/- 8.63 min; p-value = 0.0004), but the number of errors does not decrease (A: -0.14 +/- 1.51 points versus B: -0.66 +/- 1.72 points of a range of -6 to 6 points, p-value = 0.16). See the results of task 1 and 2 in Fig. 4, 5, 6 and 7.

The number of tabs being opened for task 1 and 2 is significantly lower for the users of the mock-up compared to the users of the original website, supporting the claim that the mock-up website reduces the need for outside research to gather all necessary information (A: 7.4 +/- 3.5 tabs versus B: 4.1 +/- 1.7 tabs, p-value = 0.0002).

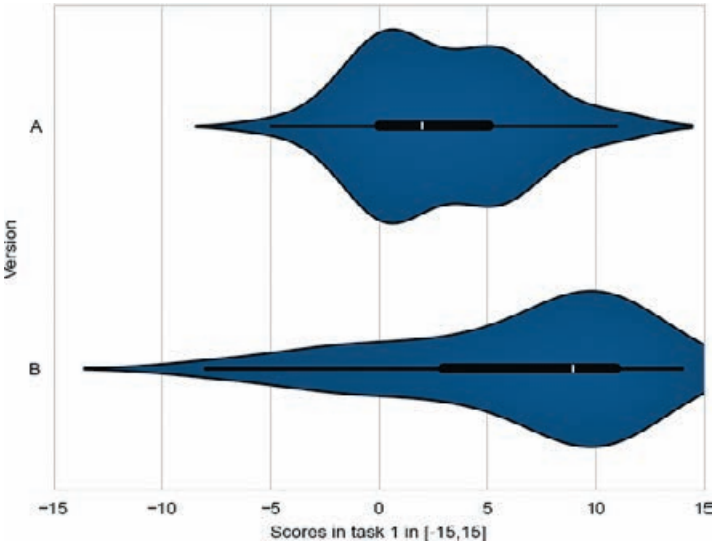


Fig. 4: distribution of the scores of task 1, grouped by website version.

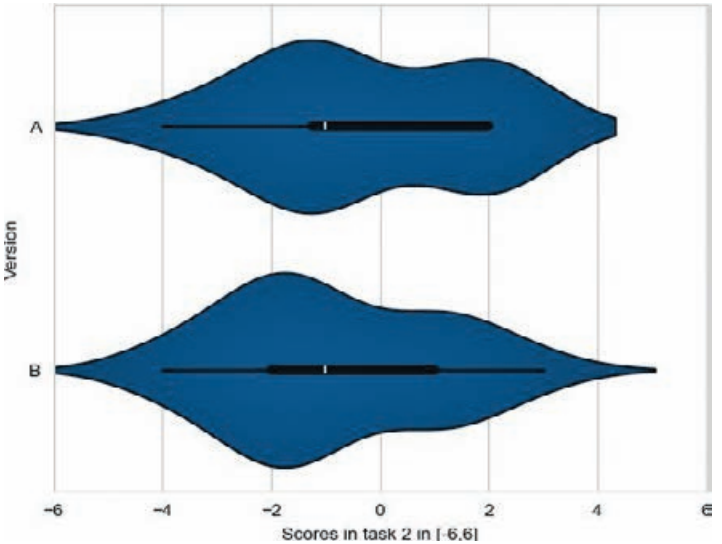


Fig. 5: distribution of the scores of task 2, grouped by website version.

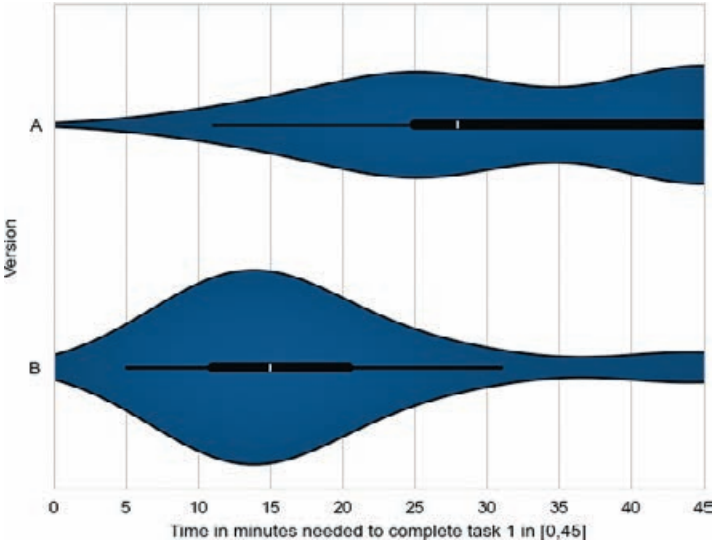


Fig. 6: distribution of the needed time for task 1, grouped by website version.

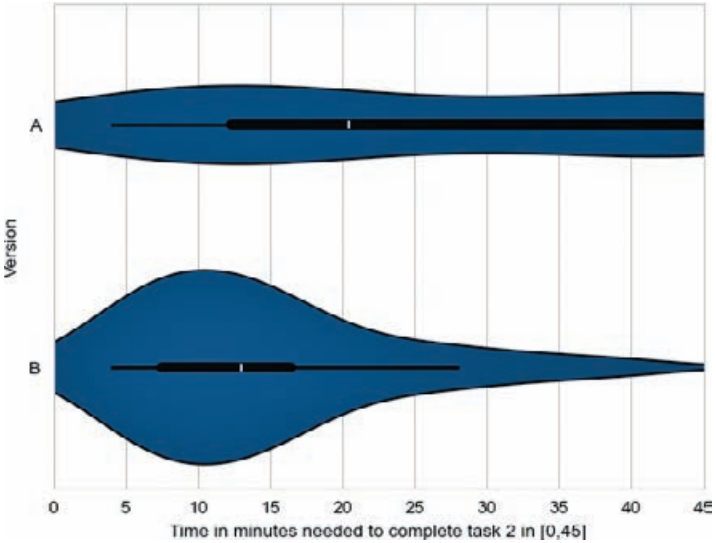


Fig. 7: distribution of the needed time for task 2, grouped by website version.

As task 1 is the most important one of the questionnaires as it comes close to the procedure necessary for a real university application process, it is investigated in more detail. Four students have indicated that they have a diagnosed learning disability, and all of them worked with the original website in the comparative tests. In mean, they reached a higher score than the non-disabled cohort: 5.00 +/- 3.65 points (learning-disabled, version A) versus 2.76 +/- 3.60 points (non-disabled, version A). This difference is insignificant (p-value = 0.209).

Another finding regarding task 1 is that the self-assessed German proficiency does not correlate with the performance. While a small trend is observable for the mock-up website, where a higher level of German language skill can be associated with fewer errors, no trend is detectable for the original website.

The results of the UEQs speak a clear language: improvements are visible in each category, see Fig. 8. As in the pre-tests, missing perspicuity is the most prominent flaw of the original website, which is cured with the mock-up. Novelty is the only category, which did not overcome the good usability threshold, yet it now has a neutral-to-positive rating instead of a negative one.

Regarding the comments by the participants, the original website received a lot of negative feedback due to its complexity and density of detailed. However, the mock-up website received the opposite criticism: some participants found it to be not detailed enough.

Some participants also mentioned that the mock-up website did not make statements about necessary language certificates. The issue seems to be that if no certificates are necessary, the mock-up does not list any certificates, which causes confusion.

Discussion

Liaising with TUM authorities, such as the Language Center and the Website Design Team, our ultimate goal is to share the results of our study with them and have a voice in the future design of TUM web pages that are concerned with application processes.

As stated in the “Results” section, those students that took on the role of a foreign student (meaning non-German) took longer, as this is usually more complex due to country-specific language and high school diploma guidelines.

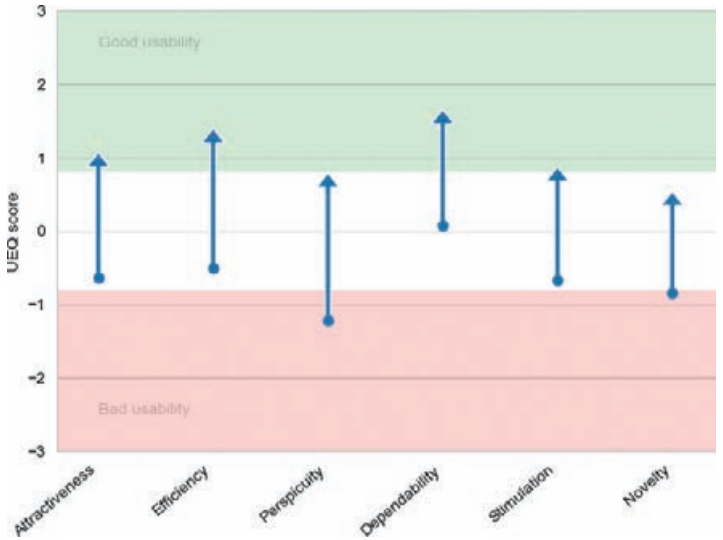


Fig. 8: evolution of the UEQ scores. The origin point of each arrow describes the score obtained with version A, and the arrowhead indicates the score obtained with version B.

The errors with respect to deadlines and language certificates can be likely traced back to the confusing layout of information on the original website, as well as the overwhelming number of available options of language certificates. The Brazilian students with German Abitur often fell for the 'trick question,' asking them to list necessary certificates if applicable when in reality there were no additional certificates needed.

It is rather telling that, out of all UEQ results, perspicuity had the worst score. This strongly indicates that the (old) website design strongly lacks the structural and linguistic adequacy to make it understandable to users across the board.

For both tasks, the students were able to solve the tasks more quickly and (for task 1) with higher scores, proving that the mock-up fundamentally improved the students' ability to understand the requirements for the application process. As previously described, the central goal of the mock-up was to provide the students with all the necessary information to complete the application process, but with information presented as concisely as possible to make it easily digestible. We reached this goal.

For similar reasons, the mock-up consequently made it possible for students to complete the tasks with a lower number of additionally opened tabs.

Interestingly enough, the self-assessed German proficiency does not correlate with the performance. A very likely reason for the absence of a (stronger) correlation is that the students assessed their skills inadequately. Some might not have been familiar with the European reference system (A1-C2) or might have simply overstated/understated their skills.

The UEQ have demonstrated that a positive change is possible. This means that an appropriate display of information in a structured, legible manner is essential to the applicants' understanding of the application process. This is why the mock-up scored higher in all relevant categories.

Nevertheless, it is important to note that an oversimplification can indeed occur, as some students noted that the mock-up was, in fact, too reductive. There seems to be a sweet spot between overloading users with information and providing them with insufficient detail that has to be found in order for websites to convey their content most efficiently. At times, users might welcome some additional information, even if it is not necessary, to gain a better sense of understanding of the entire application procedure. At the same time, the status quo seems to indicate that the most relevant group for application processes (high school students) seems to have severe issues getting an understanding of the said process and subsequently having the ability to complete it without a significant amount of additional research.

Summary

In conclusion, our study aimed to enhance the user experience, as well as simplify the information available on the TUM websites regarding the application process.

We identified that the current layout makes a successful completion of an application more difficult and often leads to misinterpretations of requirements.

Our mock-up website led to improvements in completion speed of a simulated application at TUM and higher UEQ scores. However, we did not find a correlation between German proficiency and performance.

These findings evidence the importance of a comprehensive structured content display on informational websites. They also underline that for optimal user comprehension there must be a balance between information reduction and oversimplification.

In the end, our mock-up website proves to be an alternative to the current website with enhanced user-friendliness and efficiency for prospective students at TUM.

The team hopes to have a lasting effect on how TUM application procedures are presented on their respective websites. A prospective goal is that the results and ideas for a better website design which emerged from this project will be taken into the account by TUM authorities and that there will be a continuous improvement process of the university's internet presence. We are open to further discussing our results and developing our concept in cooperation with the coordinators of the TUM website design.

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Self-reflection

As a team, we have learned a lot on this journey. We are students of Biochemistry, Engineering, Mathematics, and Informatics. Topics such as process optimization, language simplification, and usability were new to all of us. Nevertheless, it was a big surprise to us to find out how knowledge in these topics can help us to improve our own environment – our university.

Of course, learning new skills, especially those outside our own domain, is never comfortable. However, applying the scientific methods known to us from our respective domains retained our motivation to continue. Reading scientific papers, books, and news and getting on board with the current trends in language simplification and improving user experience raised our confidence to propose a new solution in a field formerly new to all of us. Being new to a topic does not mean one cannot learn it or even propose one's own ideas.

Besides this, confidence was key to the success of our project. Prior to defining our goal or even the exact topic of the project, all TUM-JA teams of the class of 2023 were asked to describe their project. Unlike other teams, we kept our description short and sweet: "We want simple language!" Initially, we presented the sentence with unease, feeling a bit foolish, but eventually, everybody remembered the motto. Thanks to that, throughout the whole project phase, it was clear to all scholarship holders what we did. And we stuck with that. Reading this report, you might think our idea was as simple as it gets. Actually, it was! It just took some confidence to propose it. We figured it is not important how scientific or elevated it sounds but if it makes our lives better.

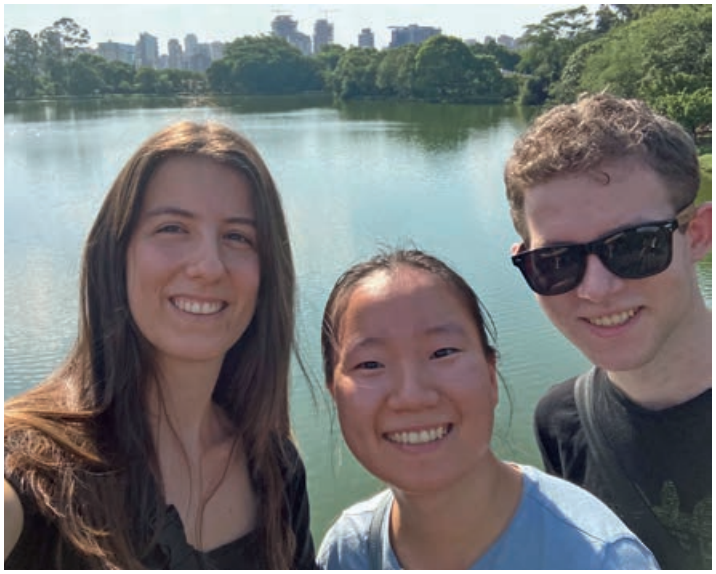
We could also write a lot about teamwork, but there is nothing that has not already been said about teamwork.

Lastly, we were honored to conduct one of our surveys in Brazil, which was a lifetime experience for all of us. Not only did we get to know another culture, but we also visited an international school and the local students there as well. It may not always be justifiable to travel around the world just for a project, but it is important to see similar projects, among others, as means of personal growth.

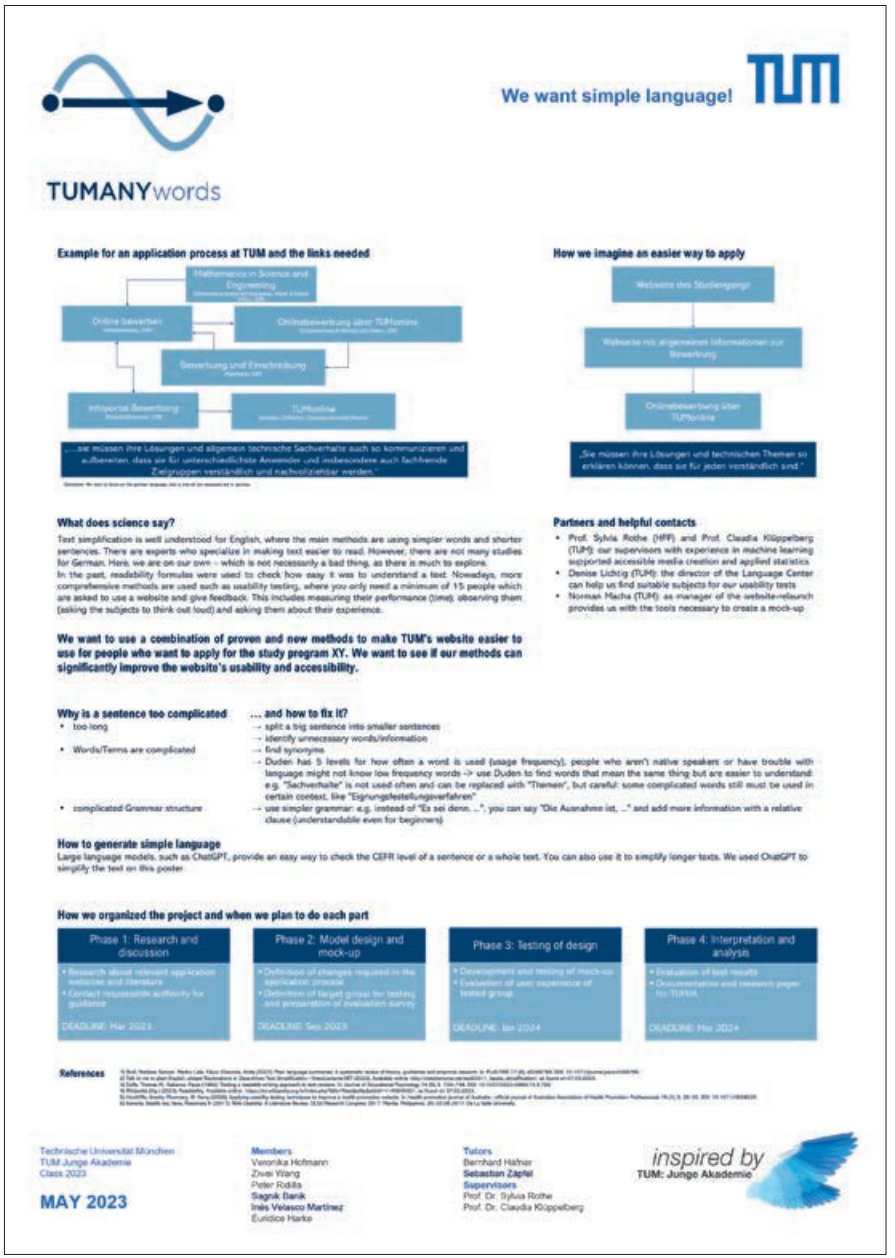
We would like to thank our supervisors, Prof. Dr. Sylvia Rothe and Dr. Claudia Klüppelberg, for heading us in the right direction throughout the project and our tutors, Sebastian Zäpfel and Bernhard Häfner, for their team support and ideas whenever critical situations arose.

We hope you enjoyed reading about our project!

On behalf of TUMANYwords, Euridice, Inés, Veronika, Ziwei, and Peter




TUM
From 0
5 minutes

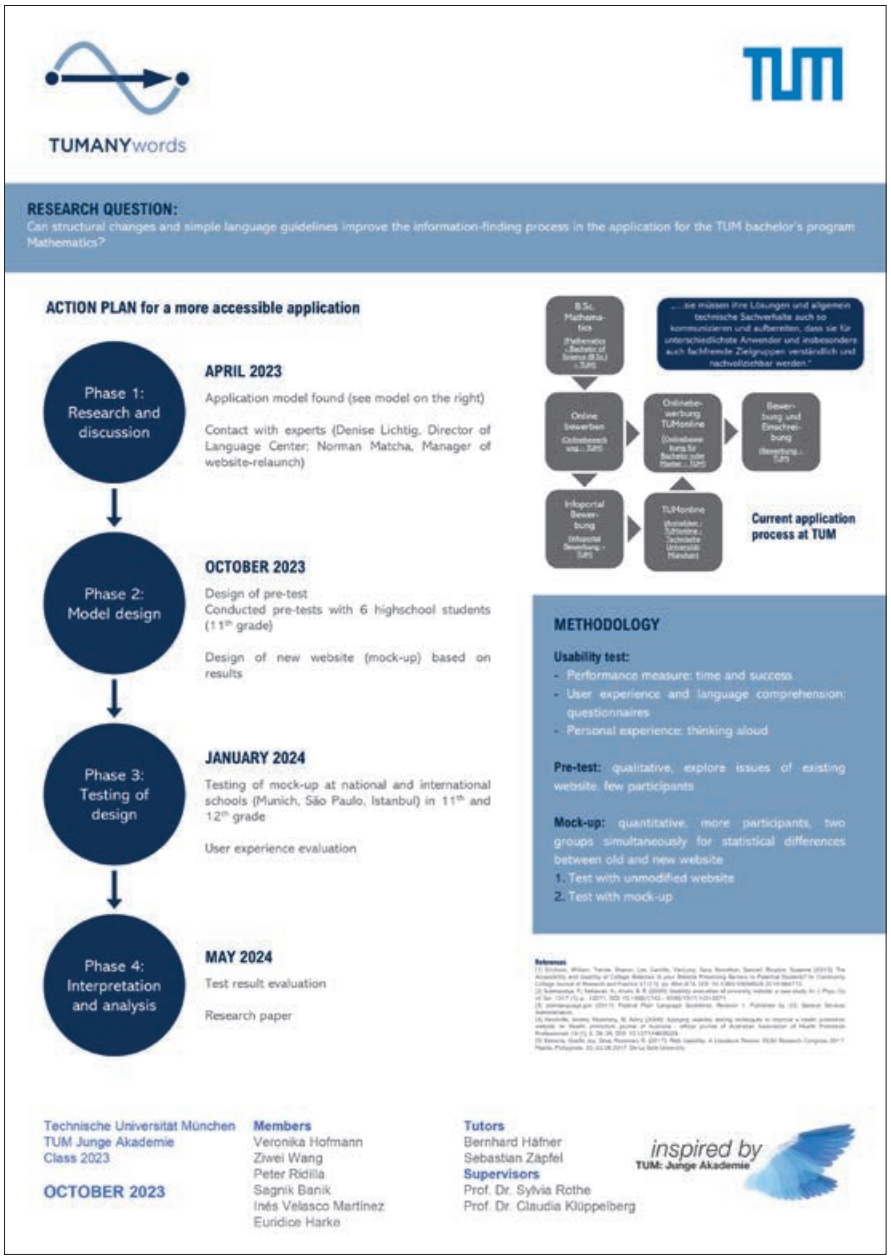


POSTER 1:

We quickly focused on TUM's application information websites for the specific study programs as a problem of readability. At first, we did not pick a specific program but collected issues with the website that are applicable to many study program websites. However, the goal was clear from the very beginning: we wanted to build a website which avoids complicated language and structure.

Also, we decided to use German as the operating language. The lack of studies for this language in particular made our project even more interesting for us.

Note how this poster still features a lot of text. Our poster communication skills evolve, as the project progresses…



POSTER 2:

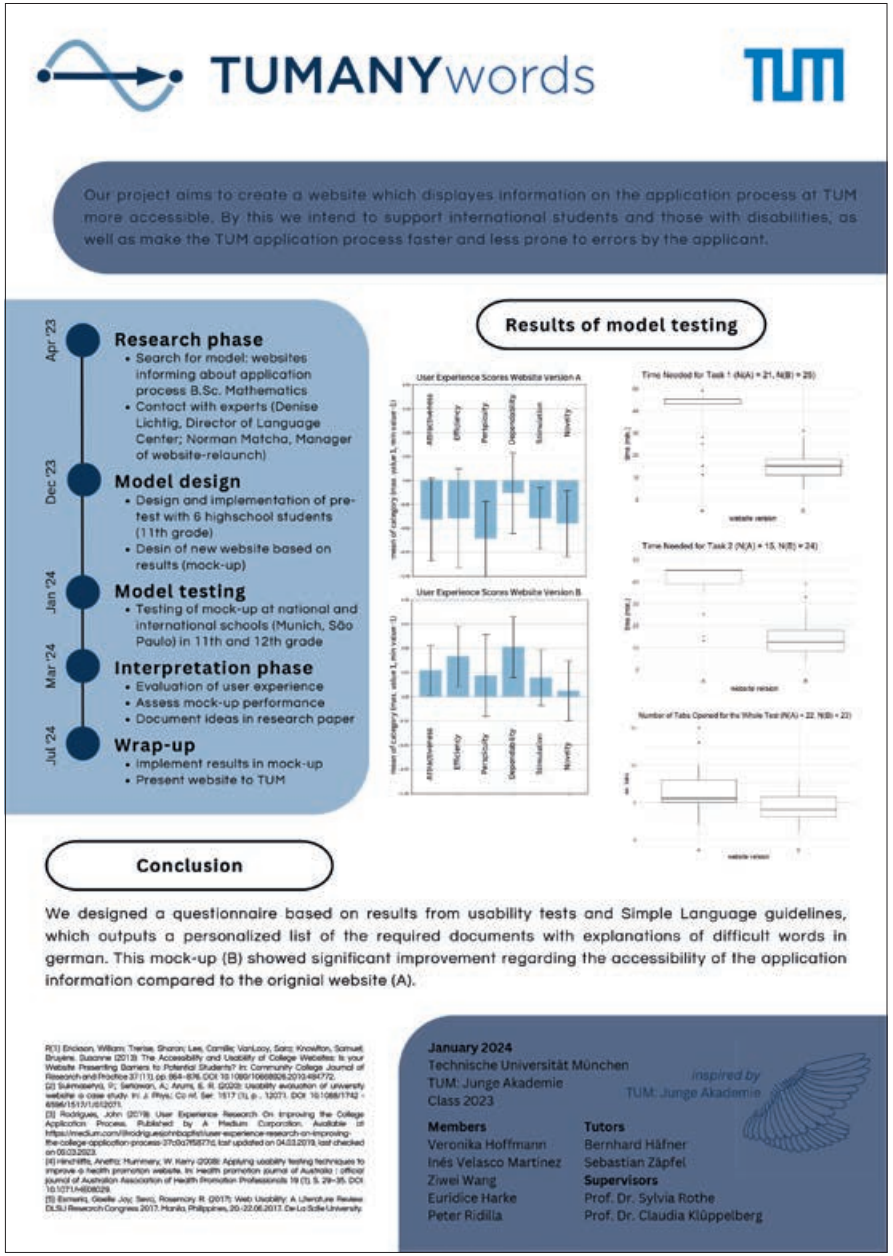
We agreed to use the bachelor's program Mathematics as our model study program.

In contrast to our original plans, we decided to perform a round of pre-tests with a small cohort of students before creating the mock-up website. This is due to the realization that without any testing beforehand, we would most likely not be able to spot the specific issues that the target group might have with the website.

With the data from these pre-tests, we were able to write the code for the mock-up website.

We contacted schools around the globe to find willing participants for our comparison tests with the finished mock-up. It was not easy to get the schools on board, but eventually and with enough patience and stressing how important data protection is to us, we succeeded and found schools in Brazil and Germany.

Also, we acquired some contacts at the TUM Center for Study and Teaching, who were open to hearing about our results. The similarity of our mock-up and the TUM Sprachnachweisfinder could make an implementation of our results realistically possible.

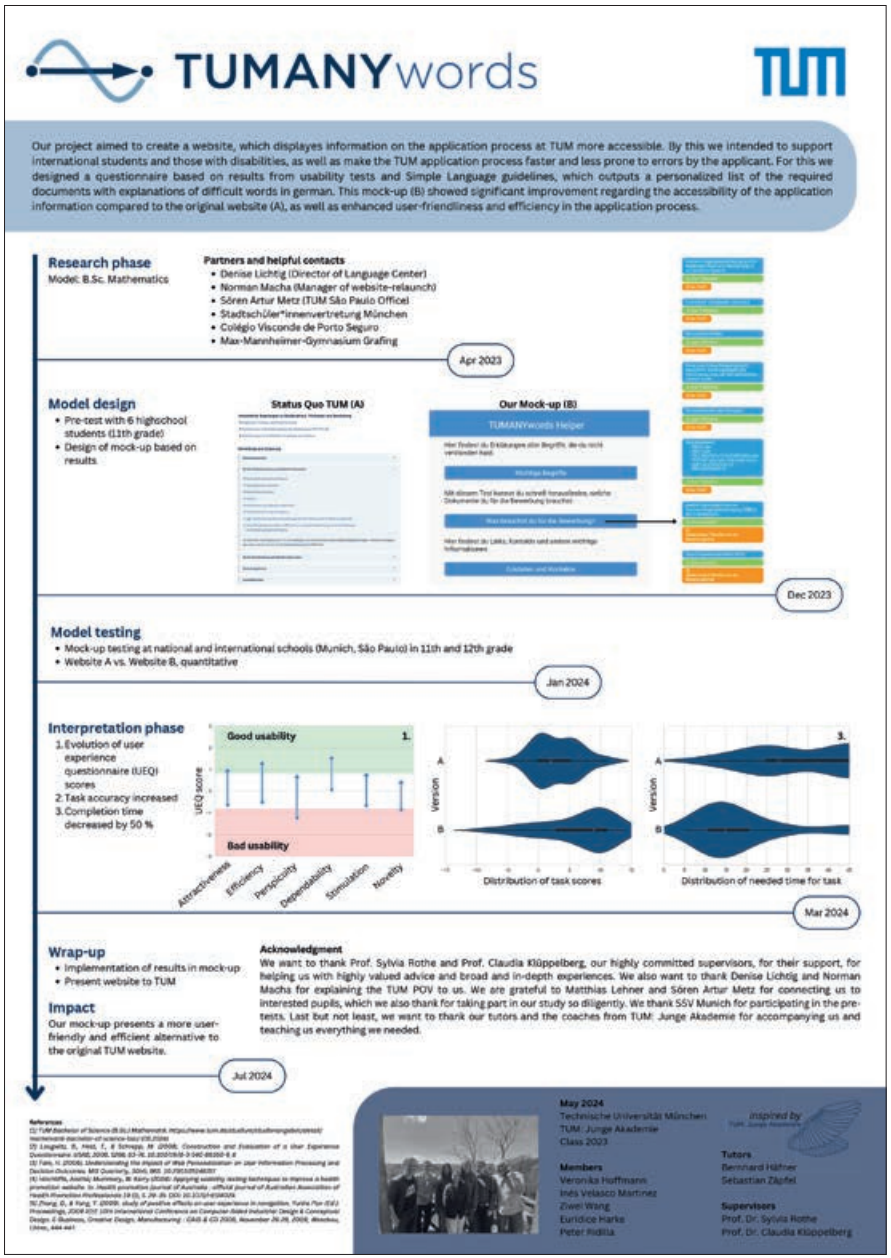


POSTER 3:

The comparison tests did not only focus on language comprehensibility, but also on user experience. This seemed to be a good addition, as testing user experience is a very standard procedure in the evaluation of websites.

We were very lucky and were able to perform all of our tests according to schedule. A division of our team (Euridice, Peter and Ziwei) flew to Brazil to conduct the tests with the German high school there, and the tests in Germany were also finished before the new year.

After the tests with the schools, we evaluated the data to make comparisons between the new and the old website. Data analysis was a bit tedious since our questionnaires were on paper, so the evaluation took some time. This is the reason why this poster does not feature all of the available data yet. However, trends are already visible: version B (our mock-up) has better usability scores and works faster and is less error-prone.



POSTER 4:

Eventually, all data is analyzed and the most important results can be seen in this poster. Even though the data from Germany that was still lacking in the previous poster qualify the positive results our mock-up generated, the data still speaks for itself and the new website offers significant improvements in user experience and overall performance. While it will remain a mystery why German natives prefer the complicated structure of the original website, it might offer an explanation to how we got to this point. We are happy with the results and will present them to the Center for Study and Teaching soon.

Highlights 2023

Highlights 2023

Highlights and Specials

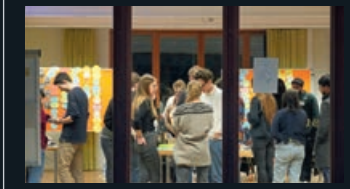
TUMJA offers its scholarship holders a wide range of opportunities for further activities. Some of these are developed and implemented by the office team, others by the scholarship holders themselves or together with partners of TUMJA.

Impulses from inside and outside enable scholarship holders and supporters to have a wide variety of experiences - in science and business, society and culture, as well as in sports and art. These encounters often give rise to new suggestions, which become new projects that are not directly related to the actual student research projects. At this point, TUMJA opens up to the entire network of TUM, partly also to the city society in Munich, and invites them to participate and to dialog.

Learn about the highlights of the past 20 months and the special projects we have been developing during this time on the following pages. ■

2022

NOVEMBER



The Kick-Off for #class23 was held on November 18-20, 2022. The scholarship holders formed five research teams under the call "Less is more."

DECEMBER

In 2022, we organized the first "Wordshop" and invited TUM students, employees from science and administration, and alumni to develop a short story themselves. The resulting stories were published in an anthology and presented at a public reading on December 15.

JANUARY

Their first Future Lab on January 20-21, 2023, brought #class23 to Schliersberg Alm. The teams learned about project management and worked on their research question. Each scholarship holder also joined one of the taskforces.

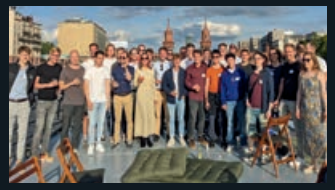
FEBRUARY

In February 2023, the Flower Power Festival started all over Munich. In keeping with the motto “Natur feiern in der Stadt," TUMJA was offering a participatory program around the flower. One highlight was the second TUMJA writing workshop "Stilblüten." See p. 168.

MARCH

The first Academy Talk 2023 was held on the topic of "New Technologies and the Perspective of Jewish Ethics." We were pleased to welcome Chief Rabbi Pinchas Goldschmidt and Prof. Dr. Astrid Séville as our talk guests.

APRIL



#class23 learned the basics of creating scientific posters at a poster workshop in April 2023. The teams used this knowledge to develop four posters for their TUMJA project during the scholarship.

MAY

May 2023 was full of inspiring events:

On May 8, we invited to another Fireside Chat, jointly organized with the TUM Graduate School. The panel discussion on "Global Science, Global Career – or the importance of the proper international personal profile" was moderated by Samira Körner and Johann Ioannou-Nikolaides, both TUMJA scholarship holders of #class23.

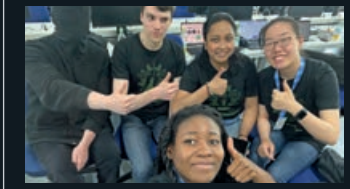
The ninth TUM Campus Run took place on May 10 in pouring rain but with a cheerful mood.

On May 12-14, the classes 22 and 23 met again at the Jugendherberge Dachau for the weekend seminars "Intermediate Evaluation 1 and 4". While the scholarship holders of #class23 further developed their project management and research skills, #class22 focused on the preparation of its symposium.

2023

2023

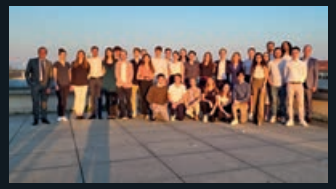
MAY



On May 19-21, we focused on „Trustworthy Systems“ at our TUM Science Hackathon. For the first time, we organized a "Snackathon" after the award ceremony as a get-together.

A visit to a performance of Antigone at the Residenztheater was organized by Taskforce Event.

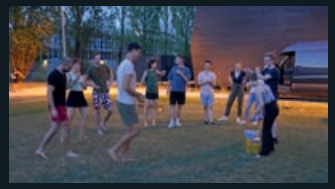
JUNE



On June 9, we said farewell to #class22 at their successful symposium on "Learning from Nature."

The IKOM 2023 on June 26-29 at the campus Garching offered again an ideal place for students to network and contact companies for the next career step.

JULY



In July, the classes celebrated a summer party at the TUM campus in Garching. While that was more of a relaxed event Taskforce Event also organized a visit to the Flowers Forever exhibition at Kunsthalle.

TUMJA also hosted the next inspiring Academy Talk, this time on the educational system in Germany. Education experts from research and practice looked at the challenges and outlined a future-proof education.

AUGUST

In July and August, Taskforce Recruiting organized three Information Events for #class24.

SEPTEMBER

Our highlight in September was our trip to TUM's Research Center Friedrich N. Schwarz in Berchtesgaden. We also visited the "Schülerforschungszentrum" and had a guided tour of the national park Berchtesgaden.

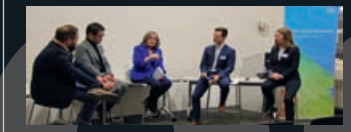
OCTOBER

At the workshop weekend Intermediate Evaluation 2 at the "Evangelische Akademie Tutzing," the spark of inspiration ignited, and the teams presented their study designs.

More than 60 candidates were invited to compete in the Selection Days of #class24, orchestrated by the #class23 scholarship holders.

NOVEMBER

In November 2023, 33 scholarship holders started as #class24. They formed five research teams under the call "What is human?"



Jointly with the TUM Graduate School, we hosted the panel "Global Skills in Research," in which two renowned scientists among the TUM Ambassadors and Liaison Officer Sören Metz, participated.

DECEMBER

The five teams of #class24, launched in November, came together with their supervisors at the beginning of December, defining their next steps at the one-day seminar in the Vorhoelzer Forum.

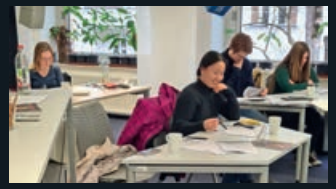
Highlights & Specials

2024

JANUARY

Facing the last months of their scholarship, the teams of #class23 trained their journalistic and scientific writing skills at the "Future Lab" on January 19-20 in Possenhofen. The new scholarship holders of #class24 focused on their project management skills.

FEBRUARY

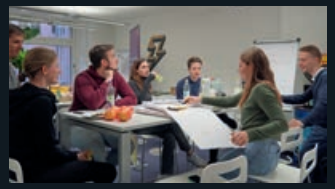


Within the second "Wordshops" session, the literary writing workshop of TUMJA, our partner ProsaThek hosted the seminar "Creative Writing - Writing as a Craft II." It gave the participants a comprehensive tool to further develop their texts.

MARCH

Taskforce Event arranged a special visit to the TURNER exhibition at the Lenbachhaus, followed by a discussion with the curator, as well as a visit to the ballet performance "Alice in Wonderland" at the Bavarian State Opera, which over 40 scholarship holders and alumni attended.

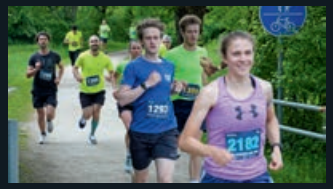
APRIL



Once Liza, Maximilian, and Nico became the new BoM leads, they held their first meeting with the scholarship holders.

On April 26-28, the classes 23 and 24 met again at Burg Schwaneck for the weekend seminars "Intermediate Evaluation 1 and 4". While the scholarship holders of #class24 further developed their project management and research skills, #class23 focused on the preparation of its symposium.

MAY



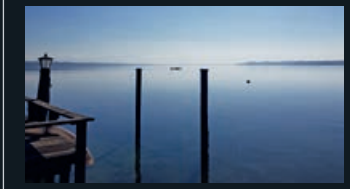
New participation record and record times: Around 2,200 TUMlings took part in the largest TUM campus run ever, which we organized in cooperation with the TUM-4health initiative at the Garching campus. The fastest running times from previous years were once again improved in all categories. Congrats to all runners!

A fantastic trio with Prof. Dr. Karen Alim, Prof. Dr.-Ing. Werner Hemmert, and Dr. Florentine Kloppenborg gave the guests valuable insights into the science career path at our summer semester "Fireside Chat" on the topic of "Global Science - Global Career". As always, our scholarship holders moderated the event, this time Annemarie and Martina from team windfo.

JUNE

On June 7, 2024, the scholarship holders of #class23 presented their findings at the annual TUMJA symposium.

JULY



The PAWE (Projektabschlusswochenende) in the beginning of July 2024 will complete the scholarship period of class23.

2024

Wordshops “Stilblüten”

Style blossoms (Germ.; Stilblüten) are usually formulations that appear unintentionally comical due to a mistake in the choice of words or word order, a slip of the tongue or ambiguity.

In the second round of Wordshops, however, things are quite different. No slipping, no mistakes – maybe a bit of ambiguity and unintentional comedy here and there.

Be that as it may. Thirteen writing enthusiasts are currently letting their literary short stories blossom under the motto “Stilblüten.” The theme however is no coincidence as the TUMJA was a partner of the Munich Flower Power Festival in 2023, celebrating nature in the city. Our floral contribution comes in the form of the new anthology which will be packed with murder, love, sadness, flowers and literally everything else you can imagine.

A big thank you goes out to the “Prosathek” – a Munich-based authors’ collective which currently helps us with proofreading, editing and valuable insights from an author’s life.

If you are interested in becoming part in our growing writing community, drop us a few lines.

wordshops@ja.tum.de ■

TUMJA SLAM

What is TUMJA SLAM?
TUMJA SLAM is a bi-weekly event where participants gather to discuss topics of interest, ranging from scientific to purely entertaining. The format is simple and engaging: each session features one or two presentations, followed by a relaxed socializing session. The primary goal is to foster connections across teams, encourage learning, and experiment with different presentation styles.

The Present
The first phase of SLAM received a positive response, bringing together around 10 presenters and 20 audience members. Each session was filled with diverse presentations covering a wide array of topics such as “immortality,” “energy,” “wicked problems,” “privacy,” “contemporary dance,” and “human thought.” This initial phase set the tone for an informal, fun, and intellectually stimulating environment where participants feel comfortable sharing their passions and curiosities.

Evolution and Expansion
As the event continues, we enter "Phase Infinity." This phase sees a slight shift in the format: now, one presentation per session allows for deeper dives into each topic. We also introduce a rotational schedule to ensure everyone has multiple chances to present different topics, and newcomers have ample opportunities to jump right in.

The Future
Looking ahead, TUMJA SLAM aims to continue its tradition of fun and intellectual curiosity. We are excited to welcome new presenters and audience members alike. ■

Record-Breaking 10th TUM Campus Run “Running Global”

Breaking News: Participation Surpasses 2200; Winner of the 11 km Race Finishes in under 35 Minutes

This year's TUM Campus Run – our contribution to TUM Global Week 2024 – once again captivated the TUM community and drew in a record number of participants. The iconic poster series featuring kangaroos, pandas, toucans, and exotic frogs highlighted the “Running Global” theme. For the tenth time, TUM members raced across the Garching campus, and to embrace the global theme, we also relaunched the #virtualTUMrun, inviting TUM network runners from all corners of the world to join. Although they were not included in the overall rankings, the worldwide runners had their own categories. It was a delight to see participants running in Greece and Poland, Japan and Thailand, as well as numerous locations across Germany.

The TUM Campus Run has not only become a beloved community event but also a significant sporting milestone at TUM. While many participants join for the fun and shared experience, the times achieved by the fastest runners are truly remarkable: the fourteen fastest men finished in under 41 minutes, with the top two clocking in at an impressive 34:14 and 35:04. To put this in perspective, the current world champion Joshua Kiprui Cheptegei completes 10 km on the track in 26:11 minutes.

Since 2013, TUMJA has hosted the Campus Run, which began as part of the student research project runTUMfit, focused on improving employee fitness. This project was the start of the race's success story, now organized annually by the office team and a group of volunteers. As in previous years, we collaborated with the Department of Sports Sciences under the leadership of the student health initiative "TUM4Health." A heartfelt thank you goes to the TUM Management Board, especially Chancellor Albert Berger and Vice President Prof. Juliane Winkelmann, for funding the running shirts and supporting the awards ceremony across 11 categories.

We're already looking forward to the TUM Campus Run 2025! Stay fit! ■


THE UNIVERSITY
OF QUEENSLAND
AUSTRALIA
ST LUCIA CAMPUS


1804
1797
1671
1596

**Street Science 2024:
A Weekend of Science and Weather Challenges**

During the first weekend of June, we brought science to the streets at the Munich ZAMANAND Festival with our event, STREET SCIENCE 2024. Despite unexpected challenges, the event was a great success, proving once again that curiosity and the spirit of research can overcome any weather.

****Rainy Start with Obstacles****
The first day of STREET SCIENCE started under tough conditions. A heavy rainstorm made setting up and beginning the event a real challenge. Nevertheless, visitors bravely arrived with umbrellas and rain gear.

Despite the weather, neither exhibitors nor visitors were deterred. Lively discussions and exciting presentations took place under pavilions and umbrellas. Scientists showcased their projects, demonstrating their flexibility and creativity. Improvised solutions and unexpected moments made the rainy day a unique experience.

****A Sunny Sunday****
Sunday brought the much-anticipated weather improvement, creating ideal conditions. The sun was shining, and the streets were bustling with life. Families and science enthusiasts filled our stands and participated in interactive activities organized by the student research team communicaTUM, who also moderated the two-day event. The atmosphere was filled with curiosity and excitement.

****Highlights and Features****
Event highlights included a robot workshop where participants learned to build their own robots and a chemistry lab showcasing amazing reactions. The renewable energy section also attracted many interested visitors eager to learn about the latest developments and technologies.

****Thanks and Looking Ahead****
STREET SCIENCE 2024 vividly demonstrated the vibrancy and diversity of the world of science. Despite the rainy start, the weekend was a complete success, made possible by the dedicated organizers, exhibitors, and enthusiastic visitors.

A heartfelt thank you to everyone who contributed to the event's success. We look forward to the next edition of STREET SCIENCE in September 2024 and are excited about the scientific discoveries and innovations to come. Stay curious and inspired! ■


StreetScienc

TUMJA Symposium 2024 #lessismore

The #class23 Concludes Their Five Projects with a Symposium – Science Fair & Slam

The call of #class23 was challenging from the start, focusing on "less is more" and the ability of each individual to concentrate on the essentials. Our distinguished guest this year, Dominik Krause, the Deputy Mayor of Munich, kicked off the evening in the Audimax, welcoming guests and scholarship holders. He offered insights into the world of local politics, highlighting how "less is more" can be a tough principle to follow in a thriving and ever-expanding city like Munich.

Our five project groups – ERIK*A, Healthy Habits, Somnoactive, Tick Talkers, and TUMANYwords – under the guidance of Taskforce Symposium, extended invitations to friends, family, supporters, and other interested parties to the closing event at the Audimax on Arcisstraße. On this warm early summer evening, they showcased their work and findings, starting with a video presentation on stage, followed by interviews with the moderation duo. In the second part of the evening, during the #ScienceFair in the foyer, they provided more details at their self-designed project stands, inviting guests to engage and interactively test their knowledge. Given the high level of interest and participation, the exhibition could have easily lasted an hour longer. Numerous TUMJA alumni also attended, witnessing firsthand how the scholarship program for science-enthusiastic students has evolved. TUM's Senior Vice President for Academic and Student Affairs, Prof. Dr.-Ing. Gerhard Müller, Director of TUMJA, and other Advisory Board members were popular conversation partners.

For the final part of the evening, the Science Slam, guests returned to the Audimax. They enjoyed riveting and humorous presentations from Nina Miller, Kati Nispel, Prof. Harald Luksch, Altan Birler, and Christina Schwalm, each delving into their fields with engaging talks. After surprising us with their topics and earning thunderous applause, the moderators surprised the slammers with avocado trees, each grown at the TUMJA office since the cohort began in November 2023. Here's to a sustainable and fond memory, and a heartfelt thank you to all our esteemed guests, scholars, and the entire dedicated organizing team. It was a truly wonderful evening. ■


I SEE
VULVAS
EVERY
WHERE


IS
MORE
Junge
Akademie

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.

“Since 2017, the presidents of the partner universities HFF and HMTM have been members of the TUMJA Advisory Board. In spring 2023, the new president of the Academy of Fine Arts, Professor Karen Pontoppidan, joined the board, thus strengthening the partnership of the academic foursome. A warm welcome, and here's to a successful and continuous further development of the heterogeneous and fantastic journey between the disciplines within the university environment in Munich!”

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.

Creating Sustainable Networks
EuroTeQ Collider at TUM: Junge Akademie

Modernizing engineering education within the European Union while creating and strengthening connections with each other and our environment – that is the aim of the EuroTeQ Collider. Since 2024, TUMJA is coordinating the EuroTeQ Collider Project Weeks at TUM.

Located at TUMJA, the Collider ties into the challenge-based learning focus that TUMJA pilots and refines within the TUM ecosystem. Similar to the projects that TUMJA scholarship holders work on, in the EU-funded Collider, student teams develop solutions to concrete problems under the guidance of experienced professionals.

Given the similarity of the learning approach, the Collider benefits greatly from TUMJA's rich network of alumni, active professors and the TUM Emeriti of Excellence, as well as young researchers. For instance, ten TUMJA alumni joined the Collider this year as trainers on agile project management, giving the Collider participants valuable insights into the topic.

The Collider expands TUMJA's exceptionally vibrant network through the EuroTeQ Alliance Universities, eight leading European technical universities working together to shape the engineering education of the future. The Collider is one of the centerpieces of this international initiative.

During this year's Collider, more than 60 TUM students tackled real-world problems from business and university environments with the support of experienced professionals and the TUMJA network. Three teams were particularly convincing with their projects and got the chance to attend the EuroTeQaThon in Paris at the beginning of June.

Let's take a close look at the successful teams.

Team "SME Trace" succeeded in the "Technology" category. Their Digital Product Passport (DPP) aims to make it easier for around 24 million small and medium-sized enterprises (SMEs) in Europe to work more sustainably and with better networking. A lack of digital resources in SMEs is one of the main reasons for problems with digital traceability, resulting in a lack of transparency in supply chains. The Digital Product Passport simplifies access to digital product information, ensuring efficient, compliant documentation. A SaaS app streamlines data input via document scanning and extraction, creating DPPs and QR codes without heavy IT investments. This empowers SMEs, fostering sustainable, transparent value chains.

In the "People" category, the "Circularity Hub" project came out on top. The hub combines an offline marketplace and online services to promote approaches to a circular economy in student halls of residence: Useful items that would often be disposed of at the end of the semester can be given away or sold here. This not only avoids waste but also fosters the local student community. The project will undergo a two-week pilot phase in the Olympic Village, after which the Circularity Hub will help improve sustainability and networks in other halls of residence as well.

Finally, in the third category "Nature", team "Farm Elf" emerged victorious. Their app provides farmers with a tool that helps them optimize the cultivation and harvesting of their fodder crops. "Farm Elf" uses satellite data and information from drones that use near-infrared spectroscopy to determine the energy content in fields. Combined with weather forecasts, this data is fed into a predictive model that recommends farmers harvest crops at the peak of their energy level. This provides livestock with better feed and reduces their greenhouse gas emissions. The climate impact of livestock farming can thus be reduced.

Winning the local phase of the Collider, the three teams travelled to the EuroTeQathon in Paris where they competed against the teams of the eight EuroTeQ partner universities. “Farm Elf” convinced the distinguished jury and won the category “Nature” on the international level.

The achievements of these remarkable teams show how TUMJA not only nurtures the academic growth of its students but also equips them with the skills to tackle pressing real-world challenges. Thereby, the EuroTeQ Collider instances TUMJA’s commitment to modernizing education within the European Union and beyond.

Our entire team has been able to learn a number of lessons and we are ready for the Collider 2025. Looking forward to exciting new challenges and partnerships in the next round of the EuroTeQ Collider! ■

“I joined the EuroTeQ Collider to have fun and gain experience and it definitely didn't disappoint! During the process, I met nice people, practiced my pitching skill, and received an internship position from my supervising professor.”

Maggie, Collider Student 2024

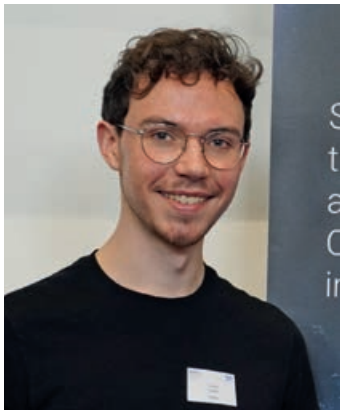
“I highly recommend future students to apply and choose EuroTeQ Collider to acquire team management, strategic thinking, problem solving and practical skills which will greatly help them in their upcoming career opportunities and networking possibilities.”

Samradnee, Collider Student 2024

“When we learned about the EuroTeQ Collider, we were very interested in the format, especially because there is a lot of room for collaborators from diverse industries to participate. The application process is also helpful to create teams consisting of students of diverse backgrounds that are genuinely interested in the topic, The fact that this is a challenge-based learning format which allows the participants to implement something tangible, with real world applications, has a great influence on their engagement.

Probably the most obvious benefit of the Collider for the challenger partners is that you get to propose a topic or project to a group of highly capable and motivated students, and see it take shape as a concept or a prototype by the end of five weeks, but that is not all. We think it is also an excellent opportunity to gain exposure as potential employer and exchange fresh ideas and new perspectives. For us it has been a great experience.”

Melissa, Alumna of TUMJA, Marketing Manager at BECONEX



"As first-time agile coaches, we were excited to apply what we had learned in our own intensive training just a weekend prior. During a 5-hour session on a Saturday afternoon, we aimed to give our participants the tools they needed for their five-week sprint.

Deciding what to teach and how to convey the agile ethos was a fantastic opportunity for us to not only deepen our knowledge, but also to learn the didactics of setting up a workshop. Watching the participants grasp the concepts and excel in their projects as a result was incredibly rewarding.

We are looking forward to many more coaching sessions in the future!"

Magalie and Philipp, TUMJA members and trainers for agile project management

Industrial Partner – Pixida Group

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.

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. PIXIDA 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 Fleet Key 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.

Over the last years, 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 or Pixida Inhouse Events with collaborative feedback sessions on research projects.

In 2022 PIXIDA hosted a coaching workshop in which a selection of class22 teams pitched their project plans and ideas to a group of experienced PIXIDA colleagues. With their different viewpoints and insights, they were able to challenge the students’ pitches. As a result, the students could identify not only risks but also further potential in their concepts.

In May 2023 we participated successfully (2nd place) in the TUM Science Hack “Trustworthy Systems” with a challenge on how to build customer trust in a retrofit usage-based insurance solution by harnessing live crash detection functions to offer proactive, tailored customer support.

For the EuroTeQ Collider 2024 project, the students devised a concept for a platform designed to organize globally distributed teams. The primary function of the tool is to facilitate both face-to-face and remote meetings using personas instead of individual calendars.

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! ■

Industrial Partner – QuantCo

QuantCo leverages its data science, engineering, and business expertise to help companies turn data into decisions. The company is headquartered in Boston and has offices in Munich, Berlin, Hamburg, Cologne, and Karlsruhe.

The team of over two hundred data scientists, software engineers, and machine learning experts creates tangible business impact by combining cutting-edge data expertise with business acumen. Its product suite includes algorithmic pricing, data-driven claims management, and high-dimensional forecasting solutions. Customers include some of the largest financial, retail, industrial, and healthcare companies in Europe and the US.

We are excited to continue our partnership with TUM: Junge Akademie into our second year! We joined the TUMJA students during a weekend at Possenhofen and introduced them to the art of analyzing and visualizing data. The workshop, presented by an alum of TUMJA, highlighted the importance of conveying technical information to a non-technical audience. This is a skill relevant to the participants' projects, which we also put into practice using their research results.

We also participated in the TUMJA Symposium and had great insights and discussions on data science, tech, and research. ■

TUMJA Alumnus Marius Merkle from QuantCo at the Visualization Workshop in Possenhofen.

Taskforces

Taskforces

Taskforces

Taskforce CAP

As with every big project, TUMJA also relies on its partners to help finance and organize some of its activities. The Taskforce CAP again proudly took responsibility for this and facilitated cooperation between TUMJA and TUM-external partners.

In 2023, we continued with the cooperation with QuantCo and Pixida as our main partners, who held workshops and other events for the TUMJA scholarship holders.

Further, we organized the TUM Science Hack 2023 – one of the flagship events hosted by TUMJA. The TUM Science Hack has a great tradition of bringing science and business together. Students, who are grouped in teams of up to 5, create innovative solutions to challenges defined by the industrial and academic partners. More than 80 students from diverse fields of study participated in the TUM Science Hack 2023.

For fulfilling this year's call "Trustworthy Systems", the jury, consisting of industry professionals, professors and former scholarship holders, awarded the best three projects. The winning teams crafted solutions for the topics AI Ethics, Crash Detection and Spacecraft Landing.

The whole CAP team enjoyed the cooperation with the partners and amazing presentations from all participants. We wish the best of success to the next year's Taskforce CAP!

Class 2023
Moritz Friedemann
Claudia Guadarrama Serrano
Vedant Gupta
Samira Körner
Peter Ridilla
Magalie Roß

Taskforce Senior
Philipp Patzelt

Class 2024
Joshua Fehn
Samuel C. Friese
Tim Knothe
Julius Mankau
Nikola Martinov Staykov
Oliver Meixner
Christian Nix

Taskforce Event

Introduction
We are Taskforce Event of TUMJA. As an independent working group, we focus on connecting current scholarship holders with tutors, alumni, and supervisors in a fun and relaxed setting. By organizing a broad variety of events throughout the year, some of which recur every year, we bring together people from different disciplines and backgrounds and strengthen our community and feeling of belonging.

How it works
Members of the Taskforce Event can decide what types of events they want to organize and which of their ideas they want to realize. Letting creativity blossom always pays off in interesting events for all current or former members of TUMJA. Together with everyone's ideas and contributions as well as the support of the TUMJA Team, almost everything is possible in the Taskforce Event.

Representing TUMJA
At the start of each semester, we organize the TUM Student Club Fair, where student organizations present themselves to potential new members, recruit, and network with each other. We also represented TUMJA at various events such as the IKOM.

Strengthening the TUMJA Community
Within the Taskforce Event, two recurring events are at the core of TUMJA: the Christmas Party and the Summer Party, bringing together scholarship holders of different years to celebrate, connect and exchange ideas.

Getting active
But these are not the only reccurring events throughout the year: The TF Event organizes the participation of scholarship holders in both the Dragonboat Race at the Olympic Lake and the TUM Campuslauf, two of the biggest university sporting events the city has to offer.

Visiting Cultural Sites
During the winter semester, we also visited several exhibitions in the museums of Munich, starting with the "Lange Nacht der Münchner Museen," where we networked with other scholarship holders and visited different museums, ranging from art to technology, in one night. Furthermore, we attended the exhibition about the Spanish painter Ignacio Zuloaga. Apart from several visits to the Kammerspiele, we went to the national ballet for the first time, where almost 30 scholarship holders, tutors and supervisors were amazed by the production of the ballet "Alice in Wonderland". Inspired by that ballet we chose the theme "Alice in Wonderland" for the upcoming dragon boat race at the end of June.

Class 2023
Florian Brandl
Johann Ioannou-Nikolaides
Sandra Gross
Alexandra Cara Marquardt
Franka Exner
Carolin Niedermaier

Class 2024
Verena Aures
Maximilian J. Frank
Maximilian Hillgärtner
Praissya Nathania
Max Schultz
Yunqing Wang

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.

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 collaborate with Taskforce Event in order to help them promote their events, work together with Taskforce Symposium to promote the TUMJA Symposium and represent TUMJA on yearly events like the IKOM. Finally, we are also responsible for conducting interviews with TUMJA alumni.

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 TUMJA. 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 at TUM and beyond.

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 they want 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.

Class 2023
Camila Loaiza Santos
Lena Maria Straßer
Tina Schiele
Shaoming Zhang

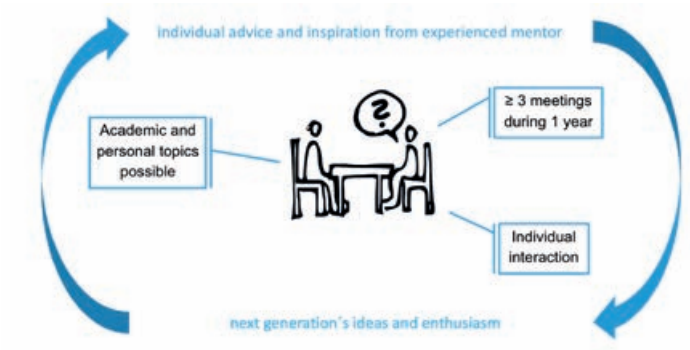
Class 2024
Bushra Demyati
Elke Haldmaier
Lucia Arens
Martina Casas Infante
Nicole Fritsch

The TUMJA Hoodies for #class24.

TUMJA's booth at the IKOM.

Taskforce Mentoring

Our mission
The taskforce "Mentoring" offers a mentoring program for current scholars of TUMJA. We strongly believe that mentoring offers great benefits for both parties and is a valuable part of the curriculum of TUMJA. Through our program, scholars are matched one-on-one with either a TUMJA Alumni or an Emeriti of Excellence. Thus, individual advice and inspiration can be passed on from experienced researchers to younger scholars. At the same time, mentors get a chance to keep in lively contact with their Alma mater and can benefit from the next generation's ideas and enthusiasm. We are proud that our program is successfully running since 2019.



Review on the last mentoring cycle
In June 2023, fourteen mentor-mentee tandems of class23 kick-started their exciting journey together. The Kick-off Event held within the Symposium in June 2023 served as a pivotal moment for these pairs to consolidate their connections and thrive in an enriching environment. In December 2023 we had the honor of organizing a get-together with the new TUM Ambassadors, a cohort of world-class international researchers who were invited to Munich and awarded the honorary title of "TUM Ambassador." Even more exciting, we were able to establish four mentor-mentee tandems between the TUM-Ambassadors and our scholars, enriching our scholars with insightful knowledge and extra guidance, especially for those planning a career in academia. Our dream as a taskforce is to transform this scheme into a new form of TUMJA mentoring which in the future will build a time-shifted additional alternative to the usual mentoring cycle. In April 2024 we were excited to welcome four new members from class24 in our taskforce-team. It was a truly enriching year for Taskforce Mentoring and we are looking forward to starting the new matching process for class24 in May and June.

Class 2023
Sophie Ebert
Veronika Hofmann
Helene Jung
Xufan Lu

Class 2024
Annemarie Weibel
Chiara Deleu
Corinna Mack
Omar Rashed
Viktoria Obermeier

Taskforce Senior
Robin Weiß

Taskforce Mentoring at the TUM Ambassador event in December 2023.

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 TUMJA on a yearly basis, our work begins with the nomination of talented students. Therefore, we are in close contact with TUM schools and departments to identify the best 7 to 25 percent of all students. 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 pandemic, we organized two events in person and one online information event last year.

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. 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 in 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. Last year we changed the place of the evaluation into the Wiki. In recent years we have established a new scoring system, as academic marks (1.0, 1.3, etc.) seemed no longer appropriate. We will continue to use this new scoring system for this year's application process as the new system facilitates 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 TUMJA. Of course, we don't lay low during the winter. We are often in contact with the other Taskforces, Event, Marketing, or CAP, and try to support them in their objectives the best we can.

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 TUMJA for the future.

At this point we want to thank all the recruiting team members and all the other scholarship holders who supported us during the most intensive tasks – reading and grading the applications and the selection days.

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Schuster, David
Velasco-Martinez, Ines
Wörrlein, Letizia

Class 2024
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Jacob, Eric
Baumann, Debora
Prock, Marius
Kellner, Maximilian Ludwig

Taskforce Senior
Schittenhelm, Andrea
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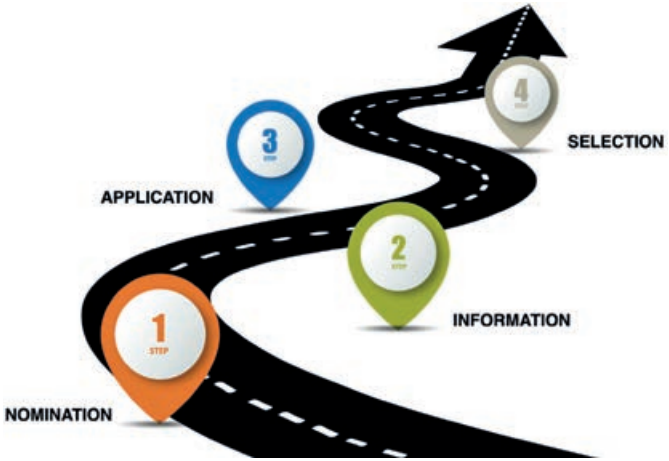

Roadmap

As every year, we are looking ahead at four 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

One special feature during the application process: 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. We applied this rule very strictly during the last application phase. All non-anonymised applications were sifted out during the application phase.

Taskforce Symposium

With all of the work that has been put into the projects shown in this report, it is only right to give them a proper send-off. We want a way to celebrate the efforts and share the topics we spent so much time on with an audience. That's the main reason why we organize the yearly TUMJA Symposium.

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 TUMJA hopefully combine the best of both worlds, embedding scientific presentations in a generally enjoyable and entertaining program.

The event typically takes place at the end of our 20-month program, and to turn it into a conceptually interesting and fun evening, we as the taskforce have full creative freedom. In a year of planning we developed concepts, scrapped them, and came up with entirely new ideas more than once. Every member of our taskforce plays a vital role in ironing out all the details of the event, from the obvious decisions to the small things you would never think of at first. During the planning process, we made sure to include ideas from the whole class and keep a close collaboration between the members of TF Symposium and the project teams.

One thing was clear: we wanted to set the main focus points on the projects that were finished, and on promoting an active exchange between the scholarship holders and attendees of the event. That's why we decided on a format where class 23 can present their ideas in a fair, with booths for every team. The evening will be closed by a Science Slam, where slammers present topics surrounding our main theme and this year's call "less is more."

Planning the symposium is an iterative process, repeating and improving with every year. In planning this year's event, we learned from the previous years' experiences, but also from our own mistakes. In general, planning an evening like this is most fun when it is done together as a team. From creative processes like finding the ideas, marketing and creative direction of the evening, to organizational tasks like booking a venue, inviting guests or communicating with the project teams and other taskforces, there were tasks for everyone. The interdisciplinarity of the team was a huge benefit in the process.

During the whole process, we were guided especially by the TUMJA office and our moderation and event professional, Jörg Puls. Our Taskforce Seniors, Paul Sieber and Katharina Küllmer provided valuable insight into the work of TF symposium in the past. Thank you for supporting us!

For a review of the symposium of #class23, go to pages 174-175.

Your Taskforce Symposium.

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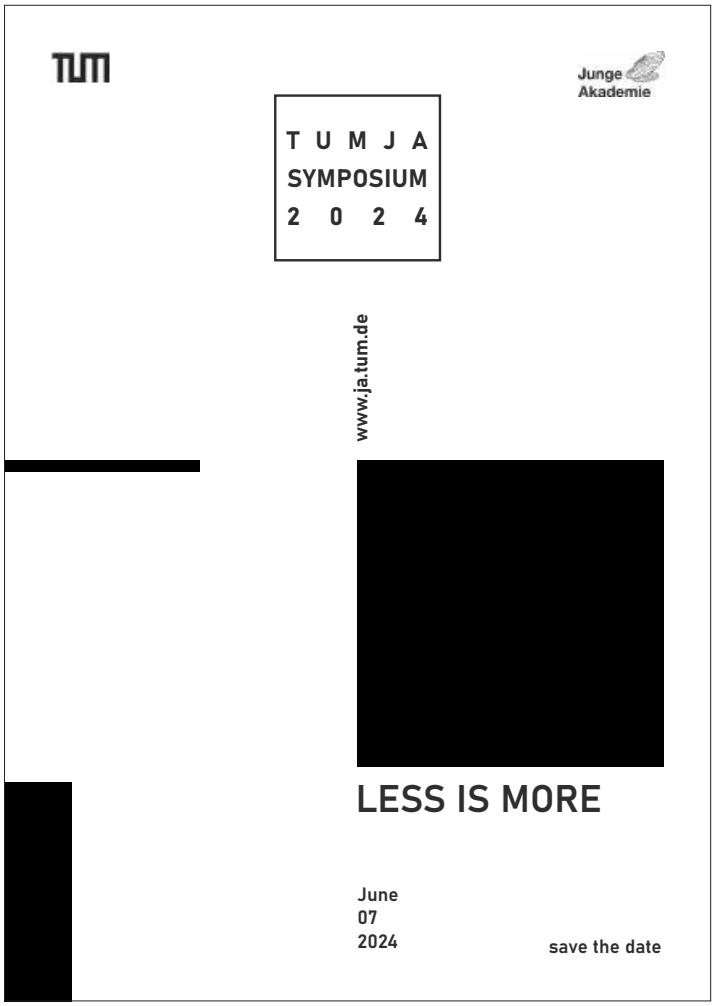
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Projects in Prospect 2024

Projects in Prospect

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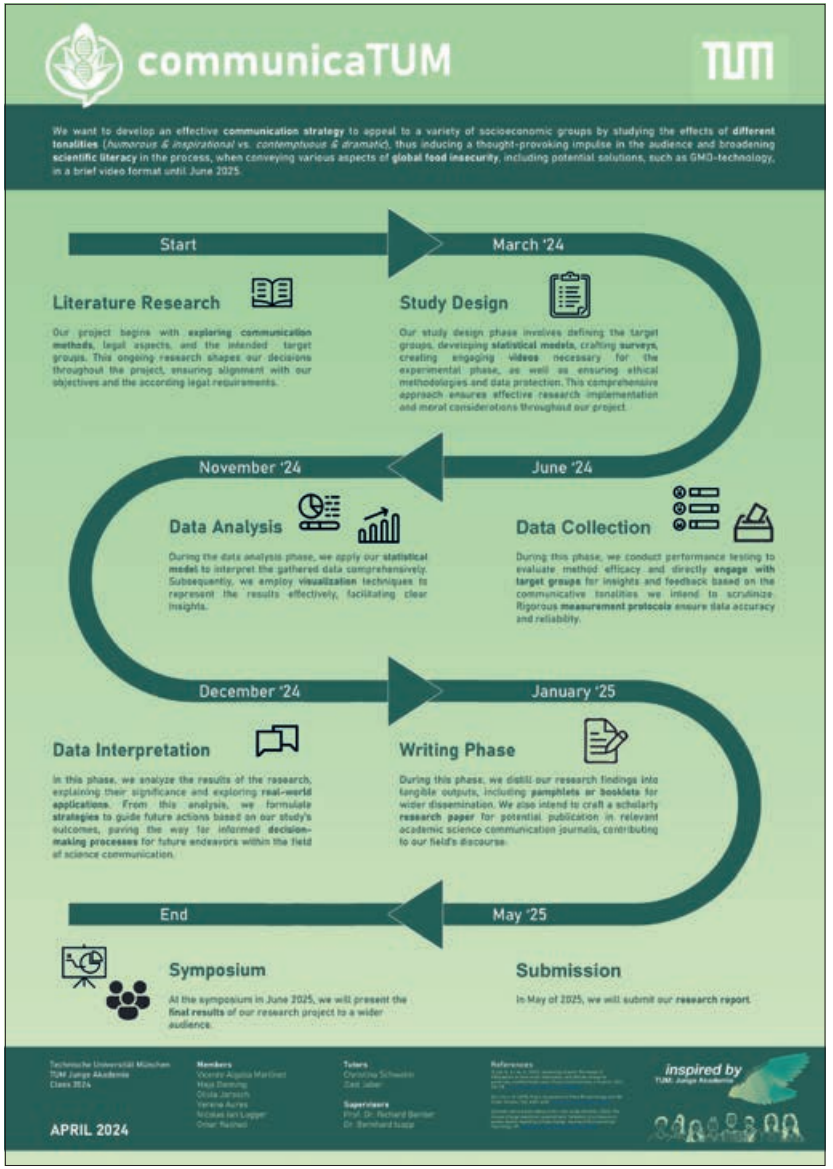

Hello everybody,

We are communicaTUM, a Life Sciences & Physics joint research group focused on scientific communication. It has come to our attention that the way pressing issues are presented tends to cause panic instead of a thought-provoking reaction or ideally action-oriented behavior. The best example of this is the current climate crisis. For instance, the manner in which data on climate change is being framed influences the public in such a way, that nowadays we are even encountering widespread "climate anxiety." We aim to address this issue and find an effective strategy that will avoid fear-mongering and in turn elicit a positive attitude change towards such initiatives. Ultimately, improving scientific literacy among the general public is the goal of our research.

As for a topic, we have chosen to focus on “Food security.” Due to its urgency and connection to climate change, we are hoping to find a very sensible public regarding this issue. In order to make our research more relevant, we will be conducting our experiments on a plethora of age-groups, from high-school students to senior citizens.

Clear and comprehensible communication of novel research findings regarding genetically modified organisms (GMOs) has the potential to substantially diminish the resistance of the German populace towards genetic engineering practices in agriculture and food production. This communication should prioritize elucidating public perceptions of GMOs concerning their potential health implications and highlighting their role in tackling global challenges such as climate change. By taking into account sociodemographic factors such as age and political orientation, a refined communication strategy could be crafted to enhance scientific awareness and rectify any misconceptions.

Our primary method consists of two surveys performed before and after one of two videos. The first survey will assess the participants’ demographic and ideological characteristics. In contrast the second survey will measure the impact the video had on the participants in multiple emotional and intellectual dimensions. The videos communicate the same scientific content in two tonalities: humorous-inspirational versus contemptuous-dramatic. The results, which are graded on a Likert scale, will then be analyzed with linear regression models and variance analysis.

In essence, using a brief video format between now and June 2025, we strive towards developing an effective communication strategy to appeal to a variety of socioeconomic groupson the subject of various aspects of global food insecurity, including potential solutions, such as GMO-technology. We hope to provoke a thoughtful response in the audience and to broaden scientific literacy in the process.

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insEYEght

Introduction

Thanks to rapid technological progress such as the advent of artificial intelligence, we can now drive blind, but for people who are actually visually impaired, the daily journey to the supermarket still poses an immense challenge. Although disabled people also benefit from technological progress, many of the 344,600 blind people in Germany still rely on tried and tested aids such as guide dogs and canes.

Is this 'state of the art'?

We would like to address this issue in our research project as part of TUMJA.

We want to make a contribution to ensure that visually impaired people can also participate in the rapid technological change that surrounds us all and thus ensure greater inclusion. In a lively exchange with experts from research and industry, as well as in dialogue with those affected, we have identified the following question as the core of our project:

Team from left to right: Chiara Deleu, Oliver Meixner, Mona Leitner (former member), Max Kellner, Max Hillgärtner, Max Schultz, Samuel Friese, Joshua Fehn, Liza Saneblidze.

Research Question
'How can wearable technologies equipped with AI be optimized to enhance accessibility and safety for visually impaired individuals?'

Methodology
In direct consultation with those affected, we will analyze which wearable technologies are best suited to providing visually impaired and blind people with information about their surroundings. This information – based on camera images – will be analyzed and processed by an AI. It must then be filtered according to its importance so as not to overwhelm the user with irrelevant information. The final and most important step is to make the collected and filtered information available to users in an intuitive way.

We are currently investigating which sensory communication channel (acoustic, verbal, tactile ...) is best suited for this.

We are also investigating the problems associated with the devices available on the market and what needs to be improved in order to provide users with a convenient solution.

We want to investigate whether artificial intelligence can contribute to improving the safety and the associated self-confidence of visually impaired pedestrians in public spaces. Finally, we are planning an empirical study to evaluate how such an intervention changes the way people move around in an unfamiliar space. ■

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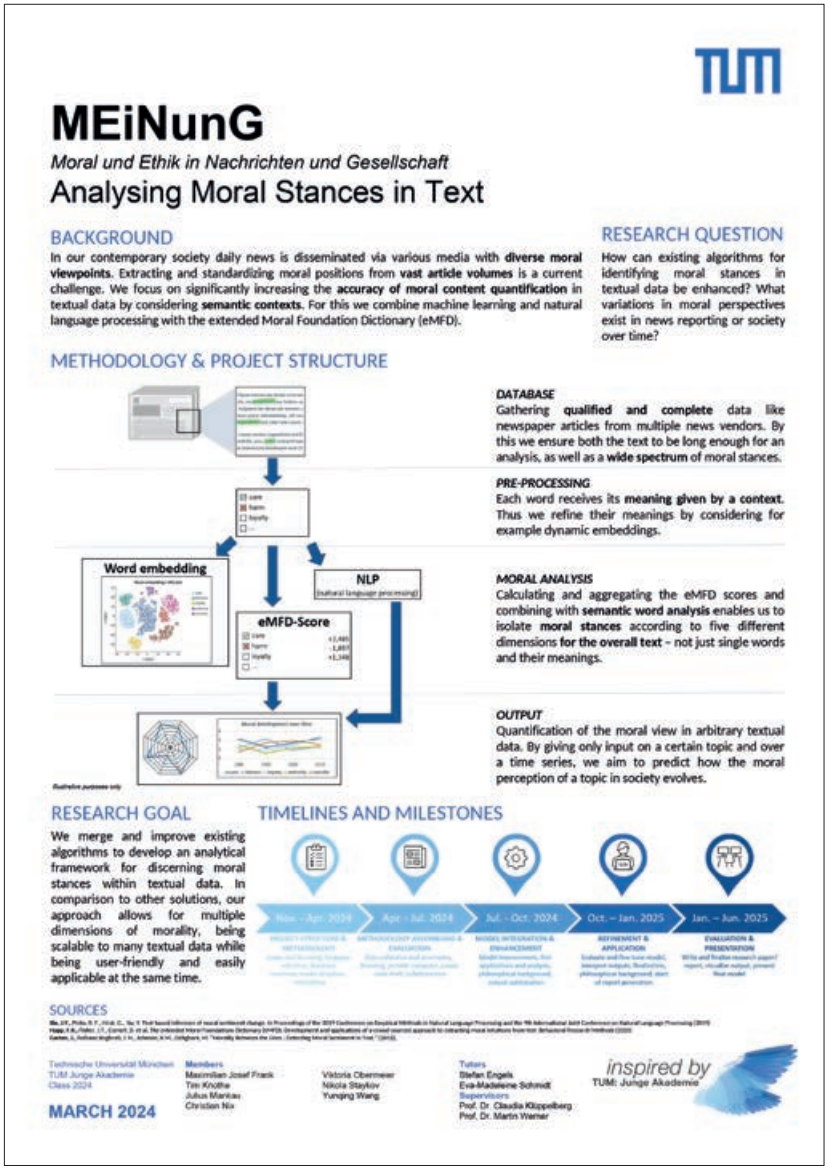
MEiNunG



Team Introduction/Background
In today's interconnected world, the dissemination of daily news via various media presents diverse moral viewpoints, reflecting the complexity of our contemporary society and the issues we face. However, extracting and standardizing moral positions from the vast volume of articles poses a challenge. The aim of our project is to enhance the accuracy of quantifying moral content within textual data.

MEiNunG is the abbreviation of the German title Moral und Ethik in Nachrichten und Gesellschaft (Eng., Morals and Ethics in News and Society). Our team consists of seven members with diverse academic backgrounds. By integrating our expertise in information systems, philosophy and medicine, our goal is to develop a user-friendly and easily applicable algorithm for analyzing moral perspectives in text. Presenting our project on the #deRSE24 conference this spring in Würzburg helped us a lot to get meaningful feedback and to expand our network.

Research question
How can existing algorithms for identifying moral stances in textual data be enhanced? What variations in moral perspectives exist in news reporting or society over time?

Research goal
We merge and improve existing algorithms to develop an analytical framework for discerning moral stances within textual data. In comparison to other solutions, our approach allows for multiple dimensions of morality, being scalable to a large amount of textual data while being user-friendly and easily applicable at the same time.

Methodology:
- *Database:* Our primary data source includes a vast collection of newspaper articles obtained from various news vendors.

- *Pre-Processing Techniques:* We employ natural language processing (NLP) tools, particularly focusing on contextual analysis through word embeddings. This step allows us to capture the nuanced semantic relationships within the text, which is crucial for accurate moral and semantic analysis.
- *Moral Analysis Framework:* At the core of our moral analysis is the extended Moral Foundations Dictionary (eMFD), which introduces five distinct moral dimensions. This tool enables us to dissect the moral content of text beyond isolated words, examining the overarching moral narratives.
- *Integration with Semantic Analysis:* By combining the eMFD with semantic analysis via NLP, we enrich our understanding of the text. This allows us to explore how moral undertones are embedded within the semantic structure of the discourse, offering a deeper insight into the interplay between language and moral values.
- *Output:* We illustrate our findings by visualizing our approach to quantification of moral values and plot changes over time concerning specific topics.

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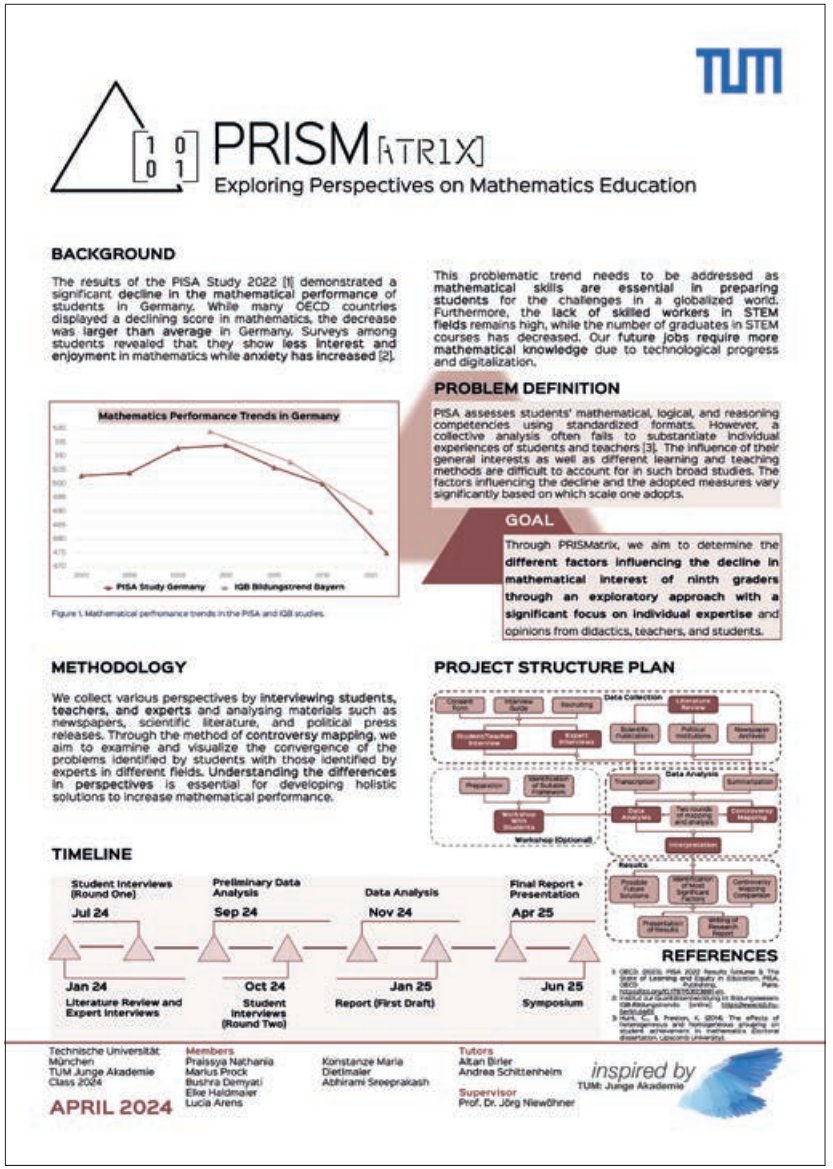
PRISMatrix



Introduction

Consisting of seven individuals hailing from diverse backgrounds, we are proud to introduce our team, PRISMatrix. United by a shared passion for creativity and education, we recognized the concerning trend revealed by the latest PISA results, particularly in mathematics. We want to address this issue on a personal level and explore the potential of creativity in overcoming it!

Background and Hypothesis

The PISA study is an international school comparison test that records the skills of 15-year-old students in reading, mathematics and natural sciences. The German PISA average results in mathematics had been rising continuously since 2000. From 2015 onwards, however, the performance trend started to decline. [1] In 2022 German students performed worse than ever before. At an average of 475 points, the students' performance is no longer significantly different from the OECD average of 472 points. urveys among students revealed that they show less interest and enjoyment in mathematics while anxiety has increased. [2] The decreasing trend in student's mathematical performance can also be observed in the IQB education trend. [3]

Mathematical skills are essential to prepare students for the challenges of an increasingly digital and globalized world. Digitalization and technologization require people with an ever-increasing understanding of mathematics. The lack of skilled workers in STEM fields remains high, while the number of graduates in STEM courses has decreased.

Goal

The factors responsible for the decline in mathematical interest of students can be multifaceted and explanations vary according to different perspectives, which range from individual students to government authorities and policy makers. Most studies tend to obtain collective data using standardized test formats. A collective analysis frequently fails to substantiate individual expe-

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1. OECD. PISA 2022 Country Notes Deutschland. 2023.
2. Lewalter D, Diedrich J, Goldhammer F, Köller O. PISA 2022 Analyse der Bildungsergebnisse in Deutschland. 2023.
3. IQB. IQB-Bildungstrends: Nationales Bildungsmonitoring auf Basis der Bildungsstandards der KMK.

riences of students and teachers, their general interests, and different learning and teaching methods. Our particular focus will be on the reasons and decisive factors relating to individual perspectives. The students and teachers are experts in their situation. We want to give them a voice! Our goal within the research project is to compare different perspectives on possible reasons for declining mathematical performance. We want to find out if the identified problems by experts and political institutions who are responsible for creating solutions align with the reality of affected students.

Methods

During our project, we will use an exploratory approach with a focus on individual expertise and opinions from educationists, teachers, and students. The exploratory approach used in the project consists of three main phases:

- *Data collection:* Literature review, expert opinions and focus groups are the primary research methods used for collecting data. Consultation with experts and professionals from PISA studies, IQB studies and didactics studies enables us to gain their insights and opinions on educational framework, mathematics curriculum, teaching methods and didactics. Expert opinions will be cross-verified with those of students and teachers through individual interviews with students and teachers from different schools in Bavaria.
- *Data analysis:* Controversy mapping is used for analyzing the data collected from the literatures and interviews. Obtained data from the literature reviews, newspaper articles, expert consultations and student-teacher interviews are used to identify the key arguments, actors and evidences with the help of visualization methods.
- *Data interpretation:* Once the controversy mapping is done, the most significant factors responsible for the decline in mathematical performance of ninth graders can be identified. It will enable us to critically compare and assess the advantages and drawbacks of the education system and deduce possible solutions to overcome the shortcomings and promote a creative and innovative mathematical experience for students! ■

Team

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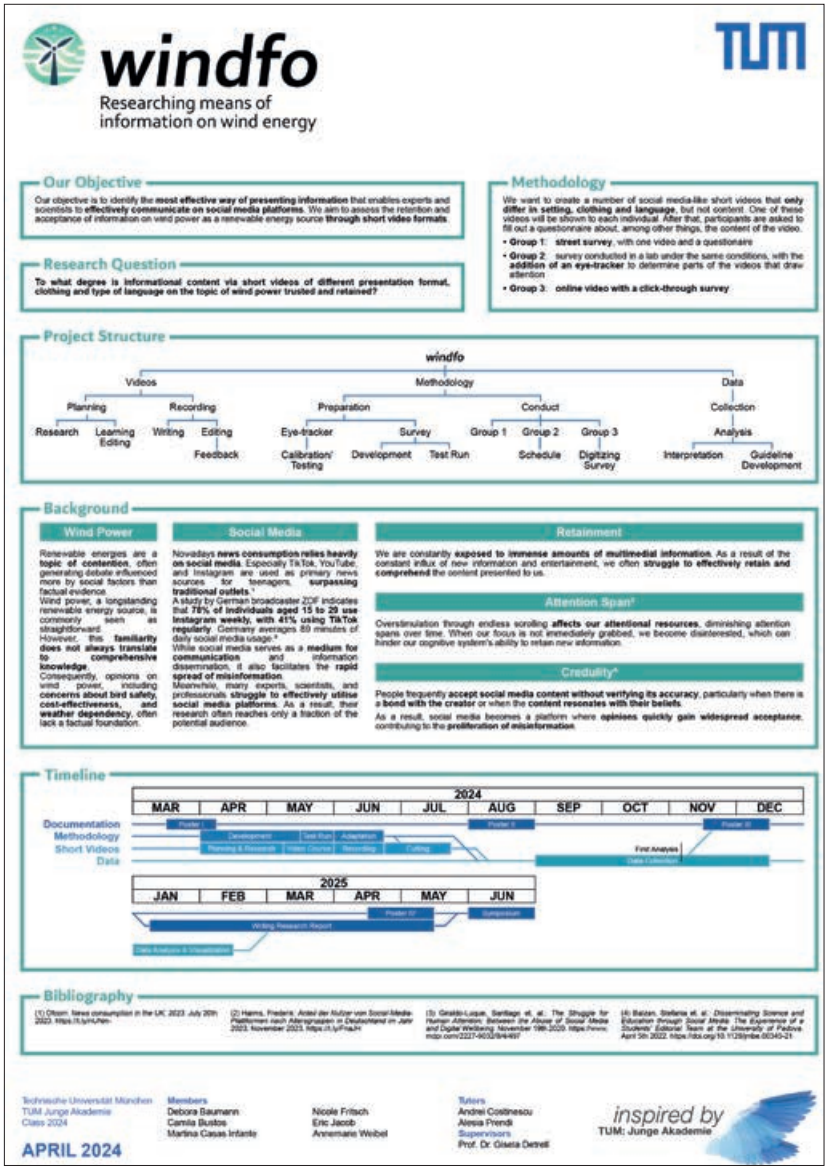
windfo



Research Question
To what degree is informational content via short videos of different length, format and pacing on the topics of wind power trusted and retained?

Our Objective
Our objective is to identify the most effective format for presenting information that enables experts and scientists to effectively communicate on social media platforms and to reach a broader and more diverse audience in an engaging and trustworthy manner. We aim to assess the retention and acceptance of information on wind power as a renewable energy source through short video formats.

Methodology
We want to create a number of social media-like short videos that only differ in format, but not content. A random selection of these videos will be shown to each individual.

There are three groups of people, each with varying demographics (that are ascertained to control for representativeness). Data is collected through the following means:

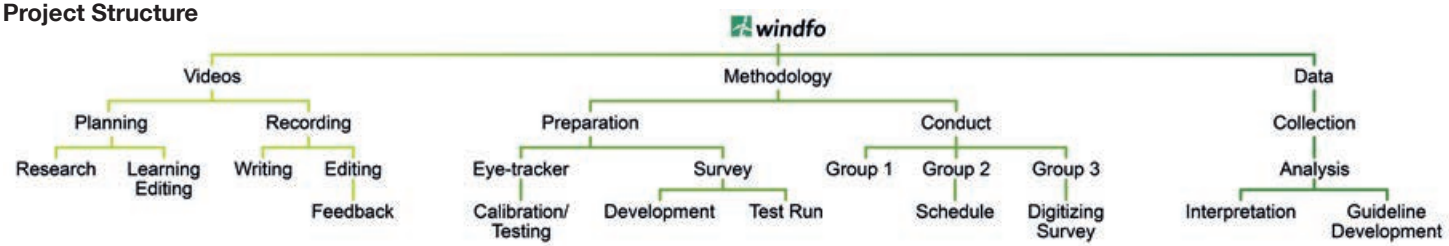
- Group 1: street survey, where people are shown one or multiple videos, with a catalogue of questions to answer after each
- Group 2: survey conducted in a lab under the same conditions, with the addition of an eye-tracker to determine parts of the videos that draw attention
- Group 3: online click-through survey with each video being followed by a set of questions

What do we want to assess?
Retainment
We are constantly exposed to immense amounts of multimedia information that can lead to cognitive overload. As a result of a constant influx of new information and entertainment, we often struggle to effectively retain and comprehend the content presented to us.

Attention Span
Overstimulation through endless scrolling affects our attentional resources, diminishing attention spans over time. We are addicted to the dopamine we get out of fast-paced videos and lose interest quickly unless our attention is constantly stimulated. Hence, people struggle to engage the cognitive system that allows our brain to retain new information.

Credulity
People frequently accept social media content without verifying its accuracy, particularly when there is a bond with the creator or when the content resonates with their beliefs. As a result of people's laxity in fact-checking, social media becomes a platform where opinions are internalised as facts and gain widespread acceptance, contributing to the proliferation of misinformation.

Project Structure



Why Social Media?
Nowadays news consumption relies heavily on social media. In particular, TikTok, YouTube and Instagram are used as primary news sources for teenagers, surpassing traditional outlets.

A study by German broadcaster ZDF indicates that 78 % of individuals aged 15 to 29 use Instagram weekly, with 41 % using TikTok regularly. Germany averages 89 minutes of daily social media usage. While social media serves as a medium for communication and information dissemination, it also facilitates the rapid spread of misinformation. Meanwhile, many experts, scientists and professionals struggle to effectively utilize social media platforms. As a result, their research often reaches only a fraction of the potential audience.

Why Wind Power?
Renewable energy is a topic of contention, often generating debate influenced more by social factors than factual evidence. Wind power, a longstanding renewable energy source, is commonly seen as straightforward. However, this familiarity does not always translate to comprehensive knowledge. Consequently, opinions on wind power, including concerns about bird safety, expenses, cost effectiveness and weather dependency, often lack a solid factual foundation. ■

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adidas

Become a Part of the TUM: Junge Akademie

Business Partner
The TUM: Junge Akademie cooperates with companies from economy and science. You, as a company, can benefit from the cooperation with TUMJA 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 TUMJA. This includes in particular
- Your (company) name on the TUMJA website
- Your name on selected publications of TUMJA as a supporting member

Scholarship Holder
The TUMJA scholarship program is open to all TUM students who are nominated by their School or Faculty or who submit an application including a recommendation letter. 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. Apart from achievements during your studies, decisive criteria are creativity, community involvement, and willingness to take responsibility. Are you interested? Stay tuned for the #class25 to apply by August 31, 2024.

You are eligible if you are
- enrolled at TUM, ADBK, HFF, or HMTM
- 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

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