Portal Wissen

The Research Magazine of the University of Potsdam

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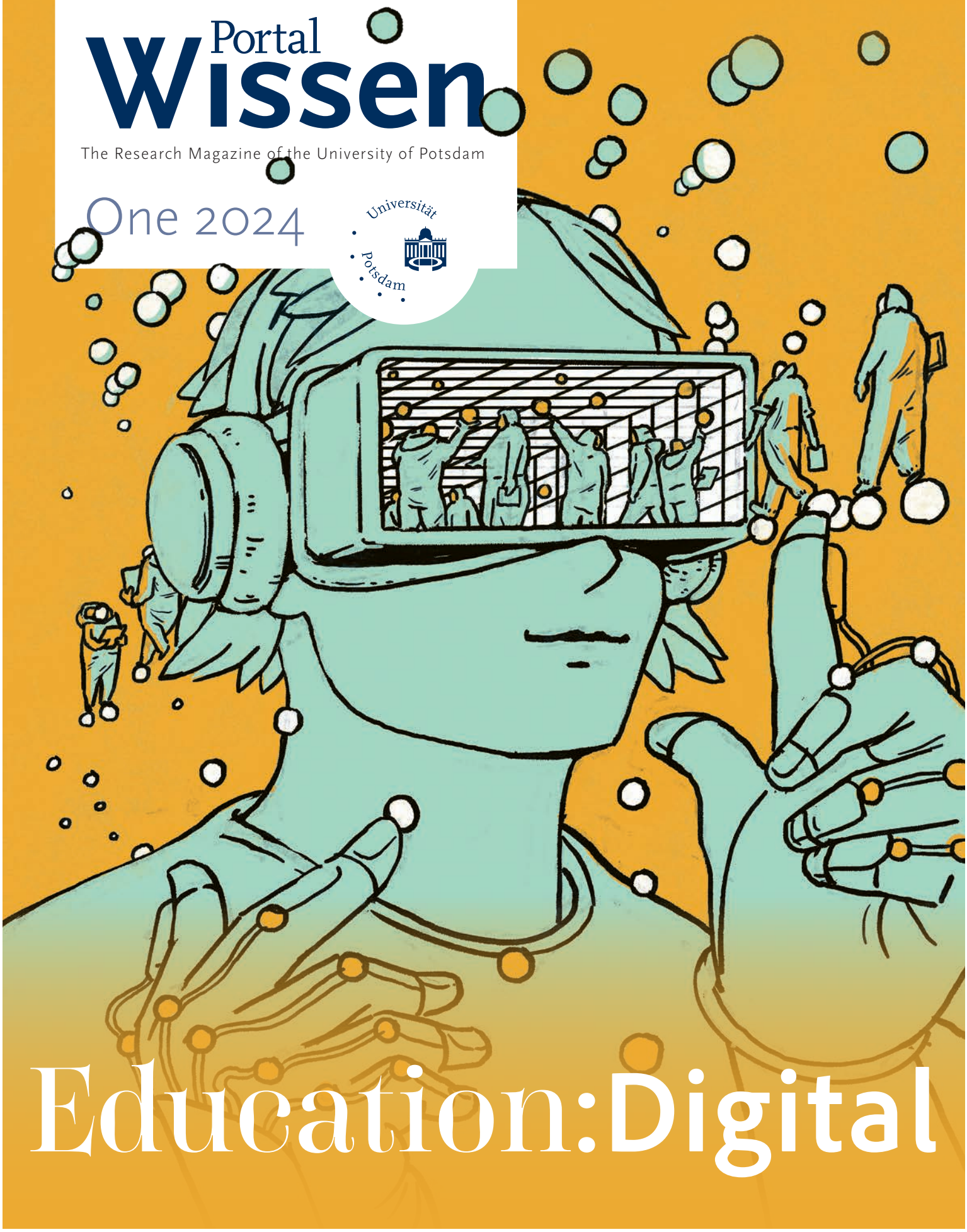
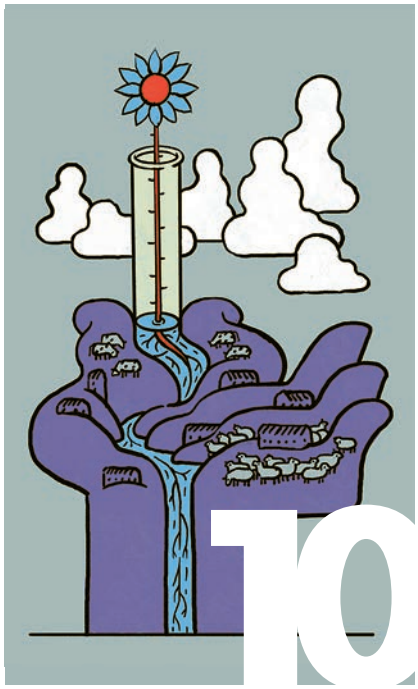
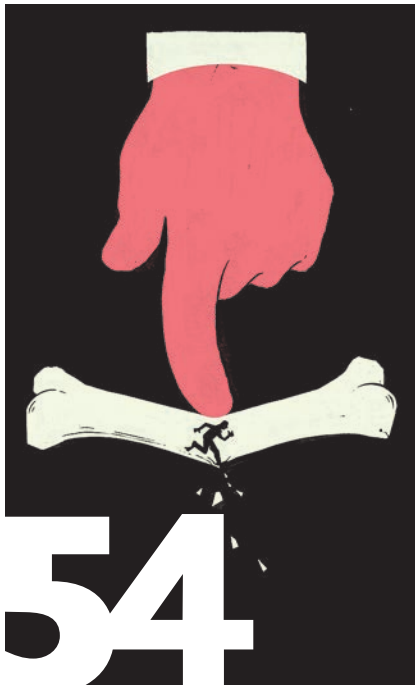


Education:Digital





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Education:Digital

Have you already swiped or liked this morning? Have you taken part in a video conference at work, used or programmed a database? Have you paid with your smartphone on the way home, listened to a podcast, or extended the lending of books you borrowed from the library? And in the evening, have you filled out your tax return application on ELSTER.de on your tablet, shopped online, or paid invoices before you were tempted to watch a series on a streaming platform?

Our lives are entirely digitalized. These changes make many things faster, easier, and more efficient. But keeping pace with these changes demands a lot from us, and not everyone succeeds. There are people who prefer to go to the bank to make a transfer, leave the programming to the experts, send their tax return by mail, and only use their smartphone to make phone calls. They don't want to keep pace, or maybe they can't. They haven't learned these things. Others, younger people, grow up as "digital natives" surrounded by digital devices, tools, and processes. But does that mean they really know how to use them? Or do they also need digital education?

But what does successful digital education actually look like? Does it teach us how to use a tablet, how to google properly, and how to write Excel spreadsheets? Perhaps it's about more than that. It's about understanding the comprehensive change that has been taking hold of our world since it was broken down into digital ones and zeros and rebuilt virtually. But how do we learn to live in a world of digitality – with all that it entails, and to our benefit?

For the new issue of "Portal Wissen", we looked around at the university and interviewed researchers about the role that the connection between digitalization and learning plays in the research of various disciplines. We spoke to Katharina Scheiter, Professor of Digital Education, about the future of German schools and had several experts show us examples of how digital tools can improve learning in schools. We also talked to computer science and agricultural researchers about how even experienced farmers can still learn a lot about their land and their work thanks to digital tools. We spoke to educational researchers who are using big data to analyze how boys and girls learn and what the possible causes for differences are. Education and political scientist Nina Kolleck, on the other hand, looks at education against the backdrop of globalization and relies on the analysis of large amounts of social media data.

Of course, we don't lose sight of the diversity of research at the University of Potsdam. We learn, for example, what alternatives to antibiotics could soon be available. This magazine also looks at stress and how it makes us ill as well as the research into sustainable ore extraction.

A new feature of our magazine is a whole series of shorter articles that invite you to browse and read: from research news and photographic insights into laboratories to simple explanations of complex phenomena and outlooks into the wider world of research to a small scientific utopia and a personal thanks to research. All this in the name of education, of course. Enjoy your read!

MATTHIAS ZIMMERMAN

Illustration: Andreas Töpfer

Illustration: Andreas Töpfer

HOW TO GET *THE DIGITAL* INTO THE CLASSROOM

The "Kompetenzverbund lernen:digital" is supposed to answer this question and show the way for introducing education science research into teaching practice

The world is digital – and school has to become digital too. The German government has understood this and launched a large research consortium: "lernen:digital" is the name of the network. Its aim is to help teachers become technically and methodologically fit at record speed to enable them to best prepare their pupils for life in a "culture of digitality". At the same time, they should also learn to combine the best of both worlds – the real and the virtual word – to support subject-specific learning. The Germany-wide network is coordinated at the University of Potsdam by Katharina Scheiter, Professor for Digital Education, and Dirk Richter, Professor of Educational Research in Educational Sciences. Both head the network and transfer office, whose task is to bring science and practice together in the field of digitalization. The Federal Ministry of Education and Research (BMBF) is funding the Kompetenzverbund with over 200 million euros.

Prof. Katharina Scheiter

"Digitalization has long pervaded our lives," Prof. Scheiter says "We use digital tools in almost all areas of life, from our jobs to our private lives. Schools should stay abreast of this development, as it is their job to teach children and young people all the important cultural techniques and how to use media competently." However, this does not mean that all teaching and learning processes that were previously analog must be replaced by digital ones. Sometimes this is even counterproductive. "Reading on a screen instead of in a book does not promote understanding, and in some cases even impairs it," says the educational scientist. To create real added value, however, digital texts could be enriched with interactive elements such as comprehension questions. Digital media also have great potential when it comes to making learning more individual and responding to the very different needs of pupils in a class. And last but not least, they offer fascinating opportunities to visualize complex processes, abstract contents, and inaccessible phenomena. Katharina Scheiter cites two examples from the natural sciences: "With VR glasses, you can travel to Mars or look inside an atom." A walk through Ancient Rome in history class or sculptural painting in virtual reality are also conceivable, as is already being practiced in art teacher training in Potsdam.

Preparing for a life in the digital world

However, all work at the Kompetenzverbund lernen:digital always proceeds from the question: What is good teaching, and how can digital media help to implement it? Prof. Scheiter knows that media should not exclusively be understood as learning tools. "We should think in a much wider sense about the educational goals of schools in terms of digitality. It is about preparing for life in a digital world and teaching how to study and learn with the help of digital tools. The respective subjects whose content we teach have also changed due to digitalization. As a result, the way we teach them should change as well.

The network is based on this holistic understanding, which aims to tap into all the knowledge on the use of digital media in the classroom that is being de-

THE PROJECT

The **Kompetenzverbund lernen:digital** shapes the dialog between science and practice for the digital transformation of schools and teacher training. Its networking and transfer office, which is coordinated by the University of Potsdam, forms the umbrella for the four competence centers, which combine the research on different subject groups. The first center deals with mathematics, computer science, natural sciences, and technology, the second with languages, social sciences, and economics, the third with music, art, and sport and the fourth with school development in the field of digitalization. The task of the centers is to develop innovative and effective methods for the digitization-related professionalization of teachers and for the digital transformation of schools.

↗ Scan to read website

Photo: Nura van Dongen

veloped at the many German universities and research institutions and to make this knowledge usable for teachers. This is why the network has been divided thematically into four competence centers, which were gradually launched in 2023: The first center deals with mathematics, computer science, natural sciences, and technology, the second with languages, social sciences, and economics, the third with music, art, and sport and the fourth with school development. The task of the competence centers is to develop effective methods for the digitization-related professional development of in-service teachers, but also for the entire digital transformation at schools. Hundreds of professorial chairs and research groups throughout Germany are involved, some of them in several projects.

The expertise of researchers from Potsdam contributes to the work of three of the four competence centers. They are involved in five different project networks, two of which are coordinated from Potsdam. One is called KISS-Pro and deals with "Artificial Intelligence in Speech and Writing". Educational researcher Prof. Dr. Katrin Böhme coordinates KISS-Pro. A second project network coordinated at the University of Potsdam aims to make so-called STEM teachers digitally fit, i.e., teachers in the scientific subjects of chemistry, mathematics, biology, physics, and computer science. This is why all science didactics departments and the Department of Education are involved in Potsdam. Like mathematics didactics expert Prof. Dr. Ulrich Kortenkamp, who is developing research-based training modules for digitally supported teaching together with his team and partners. "

Specifically, this is a basic module on coherent lesson planning with and for digital tools, which we are developing together with the Leibniz Institute for Science and Mathematics Education in Kiel and TU Dortmund University," he says. "On the other hand, we are developing an in-depth module on arguing and communicating with digital tools in geometry here in Potsdam." An exemplary learning environment has already been created and piloted in seventh grade classes in Brandenburg. The next step is to develop a suitable self-learning module.

Together with other Potsdam researchers, Prof. Dr. Isolde Malmberg is involved in the DigiProSMK network. "We are developing modules for the further training of music teachers, primarily for Berlin and Brandenburg but also beyond," says the musicologist. "Everything revolves around a contemporary way of teaching music, art, sports, and film with and about digital media. For example, making music with interfaces, inventing music in current genres, the critical and responsible use of social media and AI or AI in film music, art or inventing music in VR and AR."

Pooling results and putting them into practice

The Potsdam-based networking and transfer office, which is unique in Germany, will pool all innovations and "get them on the road". It will support the competence centers in their work, bring them into contact with each other, and bundle their results for transfer into educational practice. "This requires close cooperation with school authorities and state institutions, stakeholders in education policy and administration," Scheiter says. "We cannot train hundreds of thousands of teachers," explains the digitalization expert. "That is beyond our capacities – and it is not our job. For the nationwide transfer, we rather address those who offer further training, for example at state institutes. These are the ones we prepare and empower."

THE RESEARCHERS

Prof. Dr. Katharina Scheiter has been Professor for Digital Education at the University of Potsdam since 2022, funded by the Hasso Plattner Foundation.

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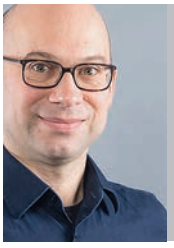

Prof. Dr. Ulrich Kortenkamp has been Professor for Didactics of Mathematics at the University of Potsdam since 2014.

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Prof. Ulrich Kortenkamp

Scheiter announces that the required knowledge will be made available and ready for use on a nationwide digital platform established by the federal states. "In this way, we can ensure that our findings do not waste away on platforms far from practice but reach schools directly via the broad qualification of teachers by the state institutes and that they become firmly anchored in the entire education system."

Bringing things into practice is also particularly important to mathematics didactics expert Kortenkamp. "Fortunately, in mathematics we can draw on the systemic work on professionalization networks at the German Centre for Mathematics Teacher Education (DZLM). So, our products are integrated into the QuaMath project initiated by the Standing Conference of the Ministers of Education and Cultural Affairs of the Laender," he says. As a result, the further training courses for mathematics could be fed into the training systems of the federal states nationwide via a network of almost 400 multipliers and thus reach up to 10,000 schools over the next few years. "At the same time, we are trying to learn from this project for the network and establish similar subject-related structures in other STEM subjects. This is a long process – the DZLM had a lead of over ten years to prepare for this."

MATTHIAS ZIMMERMANN

POTSDAM RESEARCHERS INVOLVED IN KOMPETENZVERBUND LERNEN:DIGITAL

The expertise of researchers from Potsdam contributes to the work of three of the four competence centers. Prof. Dr. Vera Kirchner, for example, works in the project "Wirtschaftspädagogik und Ökonomische Bildung: Lehrkräftebildung und Unterricht digital **(WÖRLD)**", which belongs to the competence center Languages, Society, and Economy. The network **KISS-Pro,** which looks at "artificial intelligence in speech and writing" and is intended to develop "professionalization concepts for and perspectives on the use of AI-based feedback systems and writing agents for language learning in schools", is also part of this center. Several researchers of the structural unit Educational Sciences are involved in this network, which is coordinated by Potsdam education scientist Prof. Dr. Katrin Böhme. The network **DigiProSMK** is a part of the competence center Music, Art, and Sports and researches "the digitization-related and digitally supported professionalization of teachers". Prof. Dr. Andreas Brenne, Prof. Dr. Esther Pürgstaller, and Prof. Dr. Isolde Malmberg from the University of Potsdam participate in this network. The network **DigiProMIN** is part of the competence center STEM and deals with "the digitization-related and digitally supported professionalization of STEM teachers". The network as well as the transfer office are coordinated by Prof. Dr. Katharina Scheiter. Professors of all fields of natural science didactics and the department of Education Science are involved in this network. The teams of Prof. Dr. Dirk Richter and Prof. Dr. Andreas Borowski work in the network D4MINT that is to develop "didactic double-deckers for digital education in STEM subjects".

WÖRLD
Participating: Prof. Dr. Vera Kirchner
https://lernen.digital/verbuende/woerld

KISS-Pro
Participating: Prof. Dr. Katrin Böhme, Prof. Dr. Rebecca Lazarides, Prof. Dr. Steve Nebel
https://lernen.digital/verbuende/kiss-pro

DigiProSMK
Participating: Prof. Dr. Andreas Brenne, Prof. Dr. Isolde Malmberg, Prof. Dr. Steve Nebel, Jun.-Prof. Dr. Esther Pürgstaller
https://lernen.digital/verbuende/digiprosmk

DigiProMIN
Participating: Prof. Dr. Katharina Scheiter, Prof. Dr. Amitabh Banerji, Prof. Dr. Andreas Borowski, Prof. Dr. Ulrich Kortenkamp, Prof. Dr. Rebecca Lazarides, Prof. Dr. Ulrike Lucke, Prof. Dr. Helmut Prechtl, Prof. Dirk Richter
https://lernen.digital/verbuende/digipromin

D4MINT
Participating: Prof. Dr. Dirk Richter, Prof. Dr. Andreas Borowski
https://lernen.digital/verbuende/d4mint

Photo: Thomas Roese

Jasper Tjaden

Professor for Applied Social Research and Public Policy

You are doing research on migration and integration. What interests you about it?

I am interested in the complexity of the phenomena of migration and integration, their social relevance, and the gaps in research. Migration and integration involve extremely complex processes. Social, economic, political, and legal factors play a role and that makes the research field very interdisciplinary and dynamic. Compared to the social discourse on the subject, however, many questions remain relatively unresolved empirically. These are perfect conditions for applied social sciences.

You also focus on quantitative research methods. What data do you collect and how do you use it in your work?

When it comes to the data source, I'm agnostic. As long as the data can answer my questions, I try to get my hands on it. Traditionally, these have been survey data and official statistics. Recently, however, I've also been working a lot with digital data, such as Facebook, LinkedIn, Google, WhatsApp, and Wikipedia. Computer-aided methods such as web scraping or access to company data on social internet platforms, for example, offer completely new opportunities for empirical research.

THE RESEARCHER

Prof. Dr. Jasper Tjaden has been Professor for Applied Social Research and Public Policy at the University of Potsdam since 2021.

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↗ Scan to read more about Jasper Tjaden

Where and how should the results of your research become effective?

Of course, the research is primarily intended to expand our knowledge on the topic. In my view, the best way to do this is to publish peer-reviewed scientific articles. However, I am also very actively interested in social transfer. The topic of migration evokes strong emotions, decides elections, and is covered by the media every day. I therefore try to contribute a factual, unemotional perspective. And who knows, maybe some politicians also read my studies when new laws are being formulated.

What and how can sociology contribute to alleviating people's fear of migration or migrants?

The fear of migration and of the "foreigner" is probably as old as migration itself. Newcomers to a group initially raise many questions and directly affect very deep aspects of collective identity, the social model, etc. Migration research might be able to reduce fears to some extent if it takes the pace out of the debate and emphasizes simple truths. Migration is normal in (almost) all societies and plays a central role in social and economic development. Immigrants integrate over the course of generations and, in retrospect, many fears turn out to be exaggerated. In the US, the classic country of immigration, nobody gets upset about the Irish, Greeks, Italians, Poles, or Swedes. They are all Americans. Initially, however, there was very strong rejection of European migration in the USA. We are now seeing the same process with Latin Americans and Africans. The forces of integration in society are greater in the long term than many people realize. You just have to be patient. The faster integration happens, the lower the heat in the migration debate. Applied social research can also help here by evaluating integration programs, policies, and projects. Germany was asleep when it came to integrating guest workers. A lot has happened since then. Yet many questions remain unanswered as to how Germany can better shape integration. This is where I would like to contribute.

THE INTERVIEW WAS CONDUCTED BY MATTHIAS ZIMMERMANN.

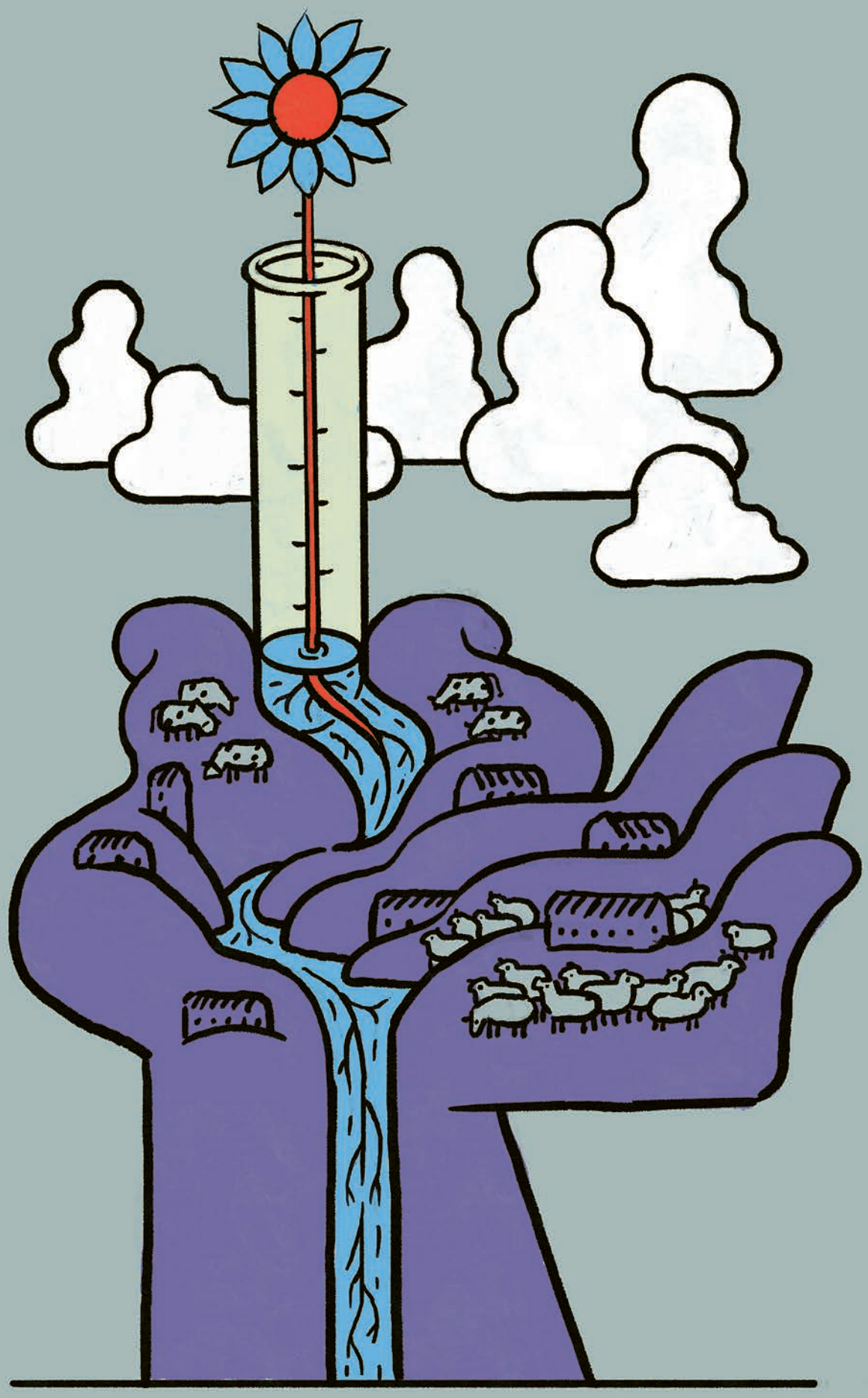


Illustration: Andreas Töpfer

MORE PRECISE, EFFICIENT AND ENVIRONMENTALLY FRIENDLY

How digital tools are changing agriculture

Can we produce food in a more climate- and environmentally friendly way? This question has been on the minds of researchers for decades and is now more relevant than ever before. New digital tools and methods could be part of the solution. Researchers from agricultural and computer sciences are working together to investigate how the new methods can find their way into practice.

The animals don't seem to mind the cool and wet weather. While the four researchers are hiding from the weather under their hoods during the tour of the farm, the cattle are eating hay in their enclosures calmly and seemingly content. 180 dairy cattle, 80 beef cattle, 100 sucking cows, 450 sheep, and 20 goats live on the grounds of the Teaching and Research Station for Animal Breeding and Husbandry (LVAT) in Groß Kreutz. The facility cultivates 940 hectares of land and works according to the rules of a farm – but is also a place of research and education. Topics such as animal welfare, different forms of husbandry, and greenhouse gas emissions are investigated here.

THE PROJECT

In the project **"DigiMix-PA – Science-Based Precision Plant Cultivation in a Mixed Agricultural Business"**, researchers develop practice-applicable solutions for a digitalized production chain in a mixed agricultural business.

Participants: Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB), Technical University Berlin (TUB), University of Potsdam (UP)
Duration: 12/2022–12/2025
Funding: Federal Ministry of Food and Agriculture

↗ Scan to read more about the project

The future Leibniz Innovation Farm in Groß Kreutz

THE LEIBNIZ INNOVATION FARM

New concepts are needed for sustainable agriculture of the future. The prospective Leibniz Innovation Farm for Sustainable Bioeconomy (InnoHof) is testing what these could look like. The existing farm will be expanded into a model farm, which will be further diversified, digitalized, and expanded to include a research biorefinery. The farm will be used to test how a circular bioeconomy that uses all accruing raw and residual materials most efficiently and produces as little waste as possible can look in practice. In the future, innovative processes and technologies will be used to cultivate algae, raise insects, process natural fibers, produce biochemicals, and make optimum use of residual materials in the integrated biogas plant. The Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB) leads the project and cooperates with numerous other research institutions to establish the Innovation Farm as a model farm. In the future, Leibniz institutions, universities, and non-university research institutions will conduct joint research here on interdisciplinary and transdisciplinary issues. Farmers and consumers will benefit from the research findings through an intensive transfer of knowledge and technology. The development of the model farm is supported with funds from the state of Brandenburg.

↗ Scan to read website

However, the plans for this facility go much further: "In the coming years, the Leibniz Innovation Farm for Sustainable Bioeconomy will be built here," explains Kathleen Bischoff, who is an experimental technician at the Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB), during a tour of the farm. Managed by the ATB, the research institute will become a model farm for a bio-based circular economy that develops and tests innovative and sustainable agricultural production methods. The infrastructure of the research facility is set to be in place by the end of 2026.

Fertilizing according to need and saving resources

The researchers from the University of Potsdam and the ATB, who are on site on this cold day, are among the many actors involved in laying the first foundations for the project. They are part of a research consortium with partners from various institutions in Berlin and Potsdam who want to test and establish new technologies at the site of the future innovation farm with the research project "Knowledge-Based Precision Plant Cultivation in a Mixed Agricultural Business" – "DigiMix-PA" for short.

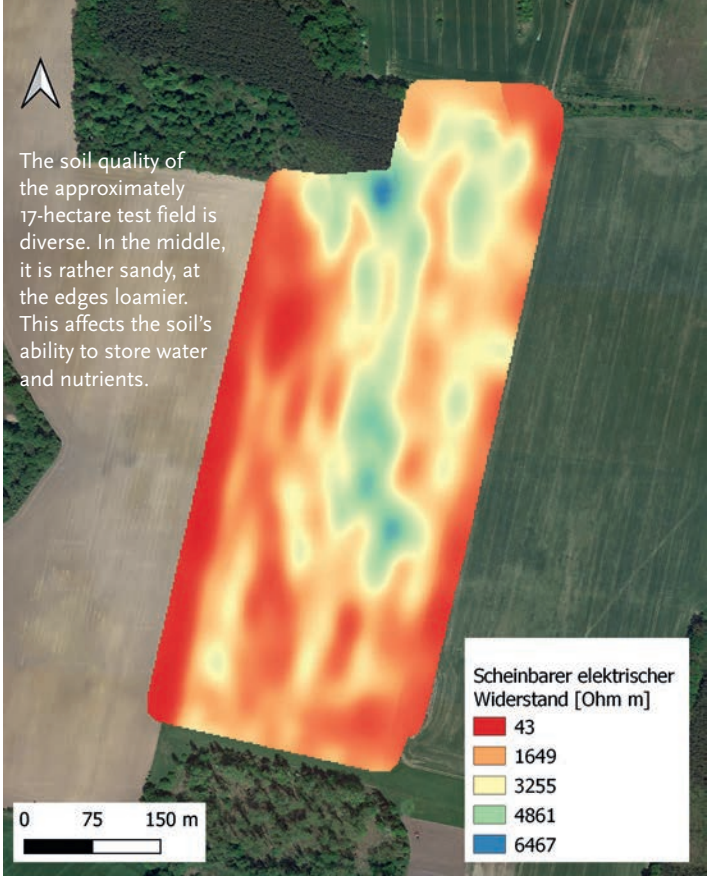
This wordy term "precision plant cultivation" refers to the idea of providing plants with exactly the right amount of fertilizer, water, or pesticides that they need to grow optimally. This saves on fertilizers and pesticides, increases yields and protects the environment. "At the moment, a field is usually seen as a whole and cultivated uniformly," explains geoecologist and soil scientist Sebastian Vogel from the ATB. "Within a few

A tractor for tilling a field

Photos: Heike Kampe (2)

meters, however, there can be major differences in soil properties and thus in fertilizer requirements, and this requires adapted management and digital tools." The goal of "DigiMix-PA" is to bring together many of these tools and test their interaction in practice.

How can we make agriculture more precise and efficient with the help of digital applications? "Science has been researching this for over 30 years," Vogel says. The list of existing tools is accordingly long – from GPS-supported automatic steering systems in agricultural machinery to sensors that measure nutrient levels in the soil and plants to determine fertilizer requirements, to drones that can detect unwanted weeds in the field from the air, using high-resolution cameras and artificial intelligence, and treat them with targeted herbicides. Nevertheless, there is a large gap between what already exists and what is actually used on the fields. "The existing technologies are still used far too little in agricultural practice," he summarizes.



The soil quality of the approximately 17-hectare test field is diverse. In the middle, it is rather sandy, at the edges loamier. This affects the soil's ability to store water and nutrients.

Many farmers are uncertain and overwhelmed

There are many reasons for this. One of them is farmers' uncertainty as to whether the necessary investments will actually pay off at some point. In addition, there are hardly any systematic solutions that cover the entire production chain of a farm. Instead, farmers are confronted with many individual solutions that focus either on the soil, plant diseases, or nutrient supply. Last but not least, there is a lack of knowledge about the correct use of digital technology. To overcome these obstacles, researchers from the fields of agricultural and computer sciences are collaborating closely in the project.

On an experimental field of about 17 hectares, they now want to investigate in concrete terms how precision plant cultivation can be implemented in practice in an integrated way and what the financial implications on the farm and the ecological impact on the environment are. "We want to combine and unite the many individual practical solutions and completely digitize the farm with all its processes, using nitrogen fertilization as an example," Vogel explains. A 5G campus network is being purchased specifically for the tests in order to transmit the various data from working machines, drones, and sensor networks in real time. Last but not least, the aim is to provide farmers with concrete assistance to make the transition easier. "Because the research results show it's worth it," he emphasizes.

The first step is a comprehensive and precise mapping of the soil, in which the researchers scan it with various sensors to determine the pH value, humus content, and soil texture in high resolution. The field studies will then start in 2024, in which the nitrogen will not be fertilized evenly, as has been the case to date, but according to need. To calculate how high the nitrogen fertilization requirement actually is, the researchers will use the soil data from the soil sensors and also measuring devices that determine the nitrogen supply to the plants. There are already sensors on the market that can be attached to a tractor, for example, and that measure, while driving across the field, whether the plants lack nutrients or are well supplied.

Is it profitable?

In order to fertilize on a needs basis, researchers need to know how much nitrogen the plants require in their respective locations and in their individual growth phases. On the other hand, it needs new technical solutions because the centrifugal spreaders used to date cannot distribute the fertilizer precisely enough across the field. For their experiments, the researchers are using so-called pneumatic fertilizer spreaders, which can place the fertilizer granules with almost pinpoint accuracy and variability. In addition, the nitrogen is not only applied to the field through mineral but also organic fertilizer. This means that the liquid manure produced by the livestock on a mixed farm is used as a valuable source of nitrogen, and material cycles are closed. A state-of-the-art slurry tank with an integrated sensor is purchased for this purpose. It measures the nutrient content of the liquid manure quickly and accurately as it is filled and spread and adjusts the quantity according to requirements.

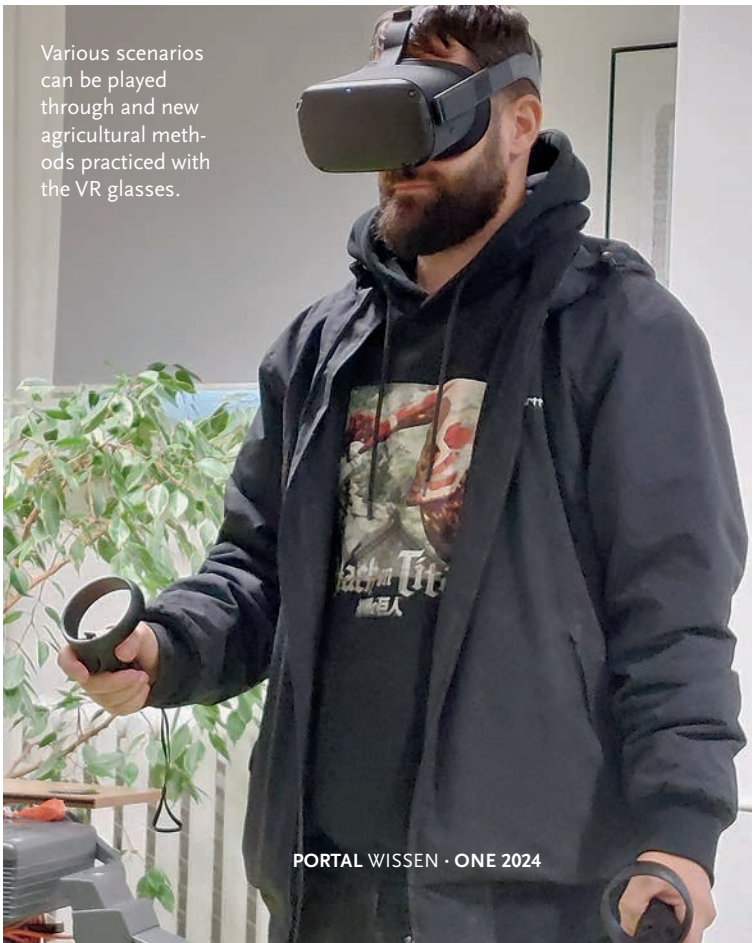
Photo: DigiMix

At the end of the tests, they look at the results of the various fertilization scenarios: How high are the costs caused by the changed operating procedures? How many additional working hours do they require? What effect does all this have on the farm's yield and profit? Can fertilizers be saved? Will less pollutants be released into the air or groundwater with the adapted fertilization?

Knowledge about material cycles, ecology, and economics is one thing. Another is the farmers who have to put that knowledge into practice – and have often been pretty much left alone so far. "It's a huge change for farmers to accept digitalization and integrate it into their business processes," Bischoff explains. "Operating resources are becoming more expensive, labor is scarce and, as a farmer, you really have to weigh carefully which measures to implement and how cost-intensive these measures are." She has observed that young farmers are more willing to use new digital methods than their older colleagues. "However, the majority is not yet convinced, uncertain, or sometimes overwhelmed."

Tractor training and time travels in virtuality

This is where computer science professor Ulrike Lucke from the University of Potsdam comes in: "Ultimately, we are using digital technology here for motor skills. And I don't acquire these by sitting at a desk and clicking my way through somewhere, but by moving and practicing the process with my body." Her colleague Florian Nowotny demonstrates what this can look like. "Please put them on," he says as he hands over a pair of VR glasses. These glasses open the door to a virtual world, while the reality of the office with desks, chairs, and the people you are talking to disappears. Anyone wearing the glasses and reaching for the displayed key will find themselves in a chugging tractor that can be steered across a field using two joysticks. Various fertilization scenarios can be simulated and evaluated. A color code on the monitor shows, for example, where too much or too



Various scenarios can be played through and new agricultural methods practiced with the VR glasses.

Photos: Ernst Kaczynski (l. o.); Heike Kampe (4)

THE RESEARCHERS

Prof. Ulrike Lucke has been Professor for Complex and Applied Multimedia Architecture at the University of Potsdam since 2010. She is head of the sub-project Transfer of the DigiMix-PA research project that transfers results of the other sub-projects into VR-based learning applications.

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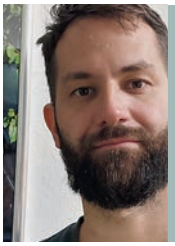

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Dr. Sebastian Vogel is a specialist in soil science. He is group leader of the working group Proximal Soil Sensing at the Leibnitz Institute for Agricultural Engineering and Bioeconomy (ATB) and coordinator of the DigiMix-PA project.

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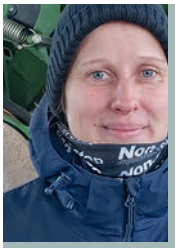

Kathleen Bischoff is an experimental technician for plant cultivation at the Leibnitz Institute for Agricultural Engineering and Bioeconomy (ATB). She works in the project Leibnitz Innovation Farm for Sustainable Bioeconomy.

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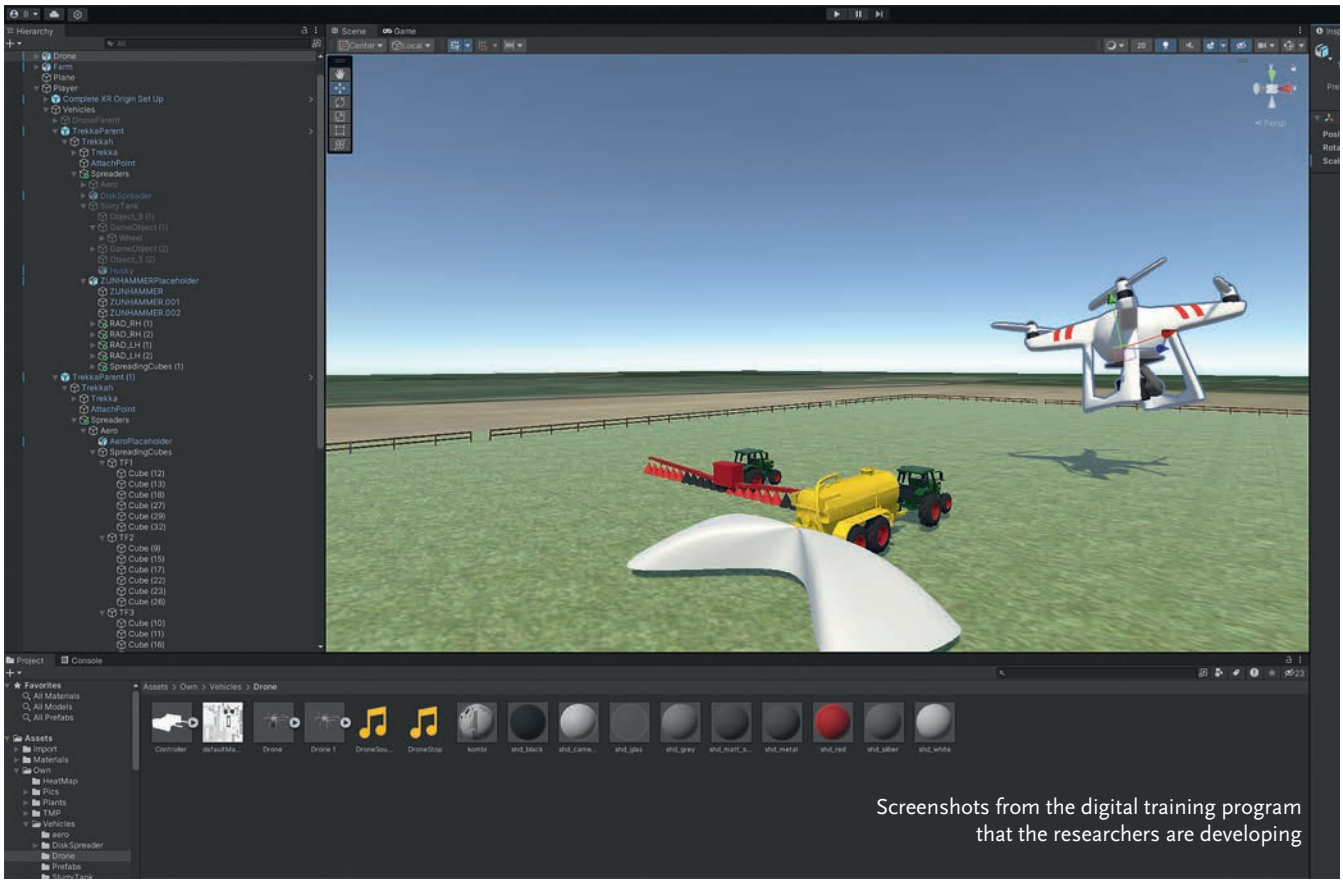

Screenshots from the digital training program that the researchers are developing

little fertilizer is being applied and what differences there are between the centrifugal fertilizer spreader and the more precise pneumatic fertilizer spreader: Red means there is too much fertilizer on the field, green means the quantity is optimal and corresponds to the actual requirement. The menu also allows you to quickly switch from the tractor to the drone: You suddenly have a virtual bird's eye perspective of the field and can see the results of your work and the effects on the surrounding area.

The application is still in its initial stage and will be gradually expanded over the coming years. "We want to create a low-threshold learning environment for farmers that demonstrates how the various technical components work together and how they can be used in a reasonable way," Prof. Lucke explains. On the one hand, the use of new technologies can be trained and tried. On the other hand, the consequences of one's own actions are made visible. What are the differences between automated and manual fertilization? What will happen to the neighboring lake in five or ten years if the fields are over-fertilized? How does the soil change during this journey through time? Will my farm still be productive and profitable in 30 years if I continue to farm as before? Various scenarios of the VR application will show all this in the future if they are linked to the experimental data.

It is still a matter of defining the individual learning objectives and developing meaningful simulations. The potential is already evident: "Such immersive technologies have a great learning effect," Lucke is convinced.

Farmers can practice with this program how to fertilize more precisely with new agricultural equipment and digital tools.

"When you are in a virtual reality and part of the whole, it is quite easy to feel affected: It affects me when my actions cause the lake to tilt or the climate to change. We want to investigate what learning effects we can bring about through this change of perspective," she says, explaining one of her research objectives. This learning effect could also be helpful for the training of future farmers or for demonstration purposes at agricultural trade fairs. As a computer scientist, Prof. Lucke does not find it difficult to think her way into agronomic topics. "Of course, it involves a lot of research. But the subject is not too distant for me. As a child, I wanted to become a zookeeper," she says and laughs.

HEIKE KAMPE

Screenshots: Florian Nowotny (2)

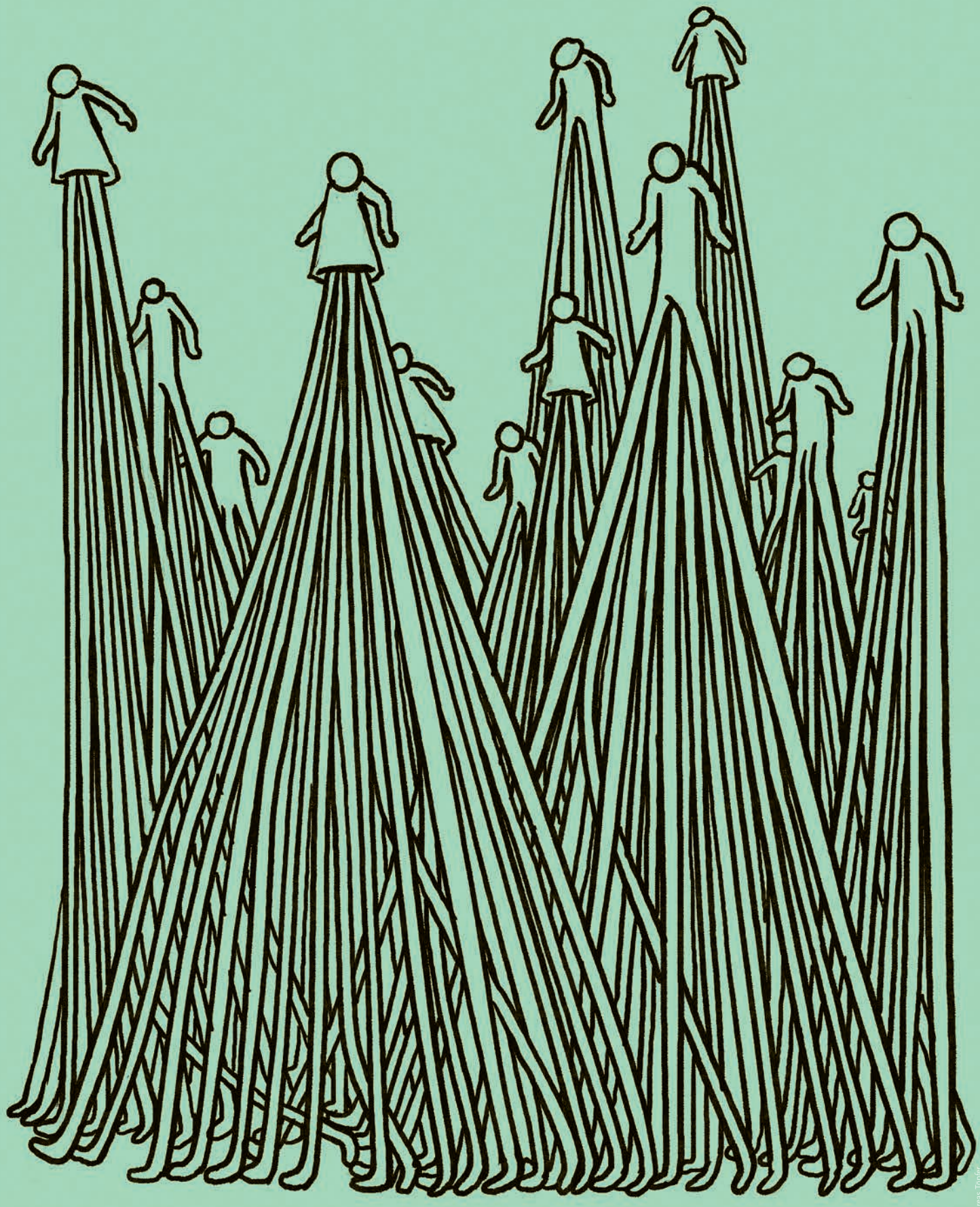

Illustration: Andreas Töpfer

GIRLS AND MATH? GIRLS AND MATH!

How Gender Influences Students' Achievement and Motivation

Women now make up more than half of all students at German universities. In subjects such as physics, engineering, and computer science it looks completely different though. Here, most of the students are male. "When you look at the competences of pupils, it doesn't have to be like this," say Prof. Dr. Martin Brunner and Dr. Lena Keller.

They have expertise in gender differences in student achievement. In the BIG-GENDER project, funded by the German Research Foundation (DFG), the two Potsdam psychologists are examining the results that children and adolescents achieve in large-scale achievement assessments – namely according to their gender. "Large-scale assessments such as the PISA study have enormous potential for us researchers," says Martin Brunner, Professor of Quantitative Methods in Educational Sciences at the University of Potsdam. For the two psychologists, this representative data is a treasure trove that they use to answer a wide range of questions about educational inequalities.

The researchers looked at three international student assessment studies with data from several million students from 1,000 representative samples to better understand the different achievements of boys and girls: the PISA study (Programme for International Student Assessment), which examines the skills of 15-year-old students in mathematics, natural sciences, and reading, TIMSS (Trends in International Mathematics and Science Study) as well as PIRLS (Progress in International Reading Literacy Study). TIMSS measures math and science skills in grades four and eight. PIRLS focuses on reading skills in grade twelve. The studies are representative samples, i.e., they reflect the overall target group of all school-age children and adolescents. Participants are selected at random and not, for example, suggested by their parents, so that distortions are excluded. "In total, over 100 countries took part in these studies, half of all countries in the world," Prof. Brunner explains.

The researchers cannot confirm that girls cannot keep up with boys in mathematics, as it is often claimed. "In Germany, gender differences in mathematics achievement among 15-year-olds are very small," Keller explains. "The skills of girls in mathematics and natural sciences at the end of secondary school are virtually on a par with those of boys – and yet girls decide against choosing STEM subjects as advanced courses in upper secondary school or pursuing an apprenticeship in this field after school," Prof. Brunner explains. However, the difference widens by the time they finish high school because many boys choose STEM subjects as advanced courses. "Until the start of upper secondary school, there would still be an opportunity to take action, for example with counselling services," Keller says.

Keller's dissertation, which initially laid the foundation for the DFG project, showed similar results. At that time, she looked at the results of girls and boys from the PISA study who were among the best mathematicians of their age in a country, and if or how they differ. "These are very special young people who have enormous potential in STEM fields and can make outstanding contributions later on," Prof. Brunner explains. Keller examined over 300 samples from the data of several million school children from 2000 – 2015, the top 5%, i.e., 114,000 young peo-

THE RESEARCHERS

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Photos: Thomas Roese

The skills of girls in mathematics and natural sciences at the end of secondary school are virtually on a par with those of boys.

ple who achieved top results in mathematics. "Boys were slightly better, but not as much as the stereotype would suggest," Keller explains. Out of five top achievements, three were by boys and two were by girls. According to the researcher, this difference does not explain the fact that women are significantly underrepresented in various STEM fields, both at university and at work.

How equal opportunity policies and student achievement are connected

The three international studies PISA, TIMSS, and PIRLS give Keller and Brunner the opportunity to compare gender differences in student achievement internationally. In the BIG-GENDER project, they investigated whether these differences are related, for example, to the level of gender equality in the participating countries. This level is determined on the basis of various aspects, namely the proportion of women in research and in higher positions such as in management or in civil service. The number of girls and women enrolled in elementary school, secondary schools and universities also plays a role. The analysis showed: The more women study at university in a country, the higher the proportion of girls with top achievements in mathematics. Keller and Brunner also found that the areas surveyed in the PISA study – reading, mathematics, and science – are at a similar level, especially for girls, if the proportion of women in higher education is bigger in the respective country. According to Keller, one explanation for this could be that parenting and teaching behaviors are different in countries with a large number of highly educated women. It is possible that a comparatively high proportion of female students at universities has a signaling effect. "It can signal to girls that achievement at school pays off," Keller says. According to Brunner, women who study and work in decision-making positions in turn break down structural barriers and allow younger female colleagues to get access to stereotypically male spheres.

For many people, such spheres also include the subject of computer science, which makes them think of solitary work in front of a computer, Keller says. "That doesn't appeal to the majority of women and girls. Many girls with a talent for mathematics are more interested in organic knowledge, in everything that is alive, such as botany or the humanities, and they want to be useful to the community." She is convinced that girls and women would be more at-

THE PROJECT

BIG-GENDER: Big data meta-analyses of gender differences in students' achievement and achievement motivation drawing on large-scale assessments.

Participants: Prof. Dr. Franzis Preckel (Trier University), Prof. Dr. Oliver Lüdtke (Leibniz Institute for Science and Mathematics Education (IPN), Centre for International Student Assessment (ZIB))
Funding: German Research Foundation (DFG)
Duration: 2020–2024

Photo: AdobeStock/Наталья Евтехова

tracted to the subject if there was a stronger focus on community and teamwork. “They should be made aware that they have great opportunities in mathematical and scientific professions with their skills and interests,” Prof. Brunner says.

Large-scale assessments (LSAs) are comparative surveys using psychological-pedagogical tests that are widely used to assess education-related knowledge.

How intersectionality influences student achievement

Keller and Brunner have also continued to develop an approach that captures how the different social categories in a person affect their educational outcomes. This provides researchers with differentiated insights into questions of intersectionality, i.e., the interaction of social dimensions such as gender, socio-economic status, and immigrant background. “Together with our colleagues, we have transferred an approach from epidemiology to the field of education,” Keller explains. “It is a highly differentiated analysis that is completely new in education research.”

Using data on German pupils from the PISA 2018 study, the researchers demonstrated how gender, immigrant background, the parents’ level of education and their occupational status interact in so-called intersectional strata and influence the reading performance of adolescents. In all intersectional groups, girls have an advantage over boys when it comes to reading. Brunner and Keller were not only able to show that the individual categories have certain effects: That girls on average perform better in reading than boys; pupils with a immigrant background have slightly lower reading skills than those without; adolescents with at least one parent with a high school diploma achieve a higher score in reading than those without; and that the greater the occupational status of the parents, the better the reading results of the adolescents.

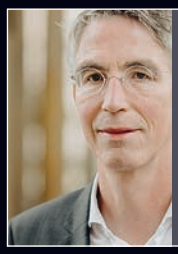
What is even more, all these aspects interact with each other, so that girls without an immigrant background with at least one parent who has a high school diploma and whose parents enjoy a high occupational status read even better than the individual categories would suggest. They are more than half a school year ahead of their peers. The interplay of social categories therefore exceeds the effects of each individual category. “Intersectionality therefore has a clear influence on student achievement,” Keller says. The researcher hopes that in the future, large-scale assessments will capture social inequalities, disabilities or chronic illnesses, as well as gender affiliation beyond “male” or “female” in an even more differentiated way, or at all. “These categories can lead to discrimination, which can have a negative impact on students’ achievement and their motivation to learn,” she says.

Funding for BIG-GENDER will end in June 2024. The researchers hope that the results will be recognized nationally and internationally and will provide opportunities for action to attract more female students to the natural sciences. After all, there is a huge shortage of skilled workers. The two researchers can already look forward to a follow-up project, also funded by the DFG, in which they want to look at the digital divide between boys and girls in primary and secondary education.

DR. JANA SCHOLZ

"… make tomorrow's Open Science infrastructures available today"

Dr. Peter Kostädt, Chief Information Officer (CIO) of the University of Potsdam



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Open Science stands for science that is open, transparent, and as freely accessible as possible: What does your personal Open Science utopia look like?

Everything that is created at publicly funded universities and research institutions can be found by everyone and reused with as few barriers as possible – be it research data, technical papers, software, or teaching materials. The motivation behind this is the core idea of Open Science: All components of the scientific process and its findings are to be regarded as common property that is made as open as possible and as closed as necessary via the internet using the tools of digitization. The greatest possible social benefit can be achieved in this way. All knowledge should be accessible across the board and without technical hurdles. The many platforms that already exist for this purpose should work together seamlessly and be able to exchange their data with each other in machine-readable form so that all information can be permanently linked and connected.

What has to be done to achieve this?

Open Science must be established as a global standard for good scientific practice. The political course for this has already been set: Open Science has been an integral part of EU research policy since 2015. In 2019, the European Commission adopted an Open Science Policy and in 2021 the UNESCO adopted its Recommendation on Open Science, which was ratified by 193 countries. Various measures are required for their implementation in the individual fields of action of Open Science. When it comes to open access, for example, we need to become less dependent on the large commercial scientific publishers, whose massive price increases are exceeding our budgets. We can achieve this by expanding our own publication infrastructures and thus creating alternatives.

How should we proceed with Open Science and why?

With an eye to the future, I would like to see greater awareness of how useful Open Science is for society. In my opinion, it is important to rethink the criteria for assessing the performance of researchers. The focus should be less on the number of publications and the publication rate in renowned journals and more on the questions of how accessible the research results are, whether the collected research data can be reproduced, and what benefits they provide for science and society.

THE INTERVIEW WAS CONDUCTED BY SARAH-MADELEINE AUST.

The University of Potsdam has summarized the key dimensions of Open Science on a new platform and published its own Open Science guidelines in 2023

Photo: AdobeStock/Sergey Nivens

EDUCATION

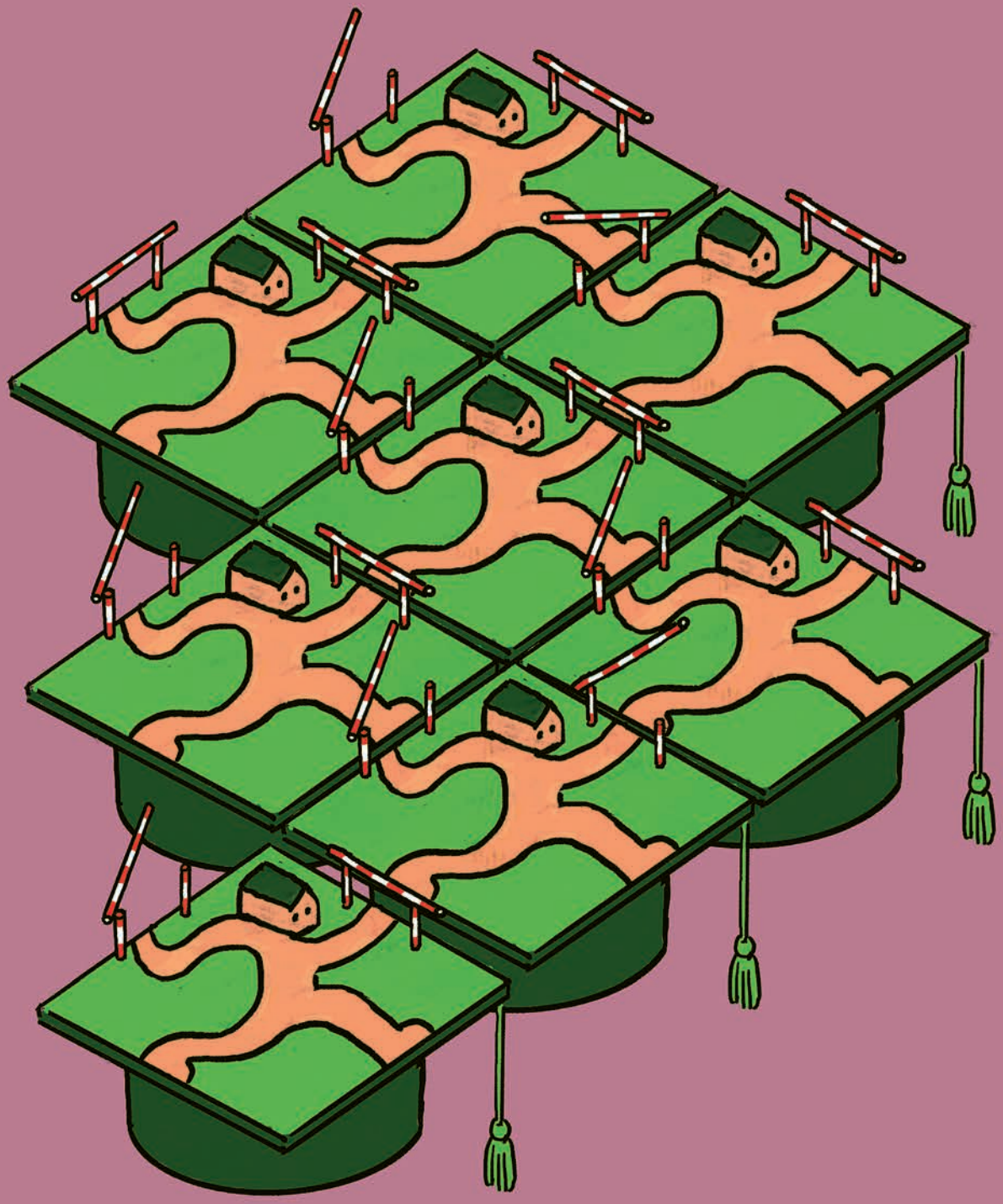

Illustration: Andreas Töpfer

WITHOUT BORDERS

Nina Kolleck investigates how NGOs are changing education systems worldwide

Across borders, more digital, and more private – how is education changing against the backdrop of globalization? Does education stop at national borders, or does it rather connect people throughout the world? Potsdam education and political scientist Nina Kolleck researches the influence of non-governmental organizations (NGOs) on education systems worldwide and across national borders. Kolleck, who is Professor of Education and Socialization Theory has been awarded a Starting Grant from the European Research Council (ERC) totaling 1.33 million euros for a funding period of five years.

Education is not only becoming more digital but also more global. The "global turn in education", as it is called in academia, is reflected in the collaboration of an increasing number of educational institutions, stakeholders, and politicians on a global level. According to Kolleck, the Bologna Reform, with which the European states have attempted to create a common higher education area, is just one example. Other instances encompass global influences on curricula, the promotion of intercultural education, and the introduction of international educational standards.

NGOs on a mission for more education

Parallel to globalization, however, she is observing a second profound change. "Particularly in the field of education, states are increasingly withdrawing and other players are filling this gap, such as international

THE PROJECT

EmergEd – The Emergence of Global Non-Governmental Spaces in Education: Non-Governmental Organizations and the Global Turn in Education

Funding: European Union / ERC Grant
Duration: 2023–2027

↗ Scan to read more about the project

Prof. Kolleck with her colleague Dr. Ronny Patz

THE RESEARCHER

Prof. Dr. Nina Kolleck has been Professor for Education and Socialization Theory at the University of Potsdam since 2023.

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organizations, multinational companies, and NGOs," Prof. Kolleck says. The work of international organisations such as the UNESCO or the OECD in the education sector has already been well researched, in contrast to NGOs at a global level. "We still hardly know what role they play and how they influence education," Kolleck says. It is clear that in the course of this "global turn", NGOs are increasingly establishing transnational networks to design and implement education together. They are working at various levels with different and sometimes contradictory aims – for example, to reduce educational inequality, introduce innovative teaching methods, provide educational resources, or support neoliberalism or businesses through influencing education.

One example is "Teach For All," a network of NGOs from over 50 countries that have joined forces with the aim of "radically transforming education systems around the world by focusing on the provision of educational concepts in various countries," as Kolleck stated. Their locally operated and funded partner organizations train university graduates and executives who then teach in classrooms within their countries for two years – precisely where they are needed most. Additionally, "Teach For All" ambassadors continue to advocate for the improvement of educational opportunities for children worldwide throughout their careers.

How exactly these networks influence the education systems is still largely unexplored. Education and political scientist Nina Kolleck plans to investigate this change in more detail with the help of the ERC Starting Grant. "In times of increasing inequality, I hope that the project will help to shed light on the work of new players in the education system and strengthen equal opportunities worldwide. This is also of crucial importance for stable democracies."

The project does not focus on individual NGOs but on their association to form so-called transnational networks. In addition to "Teach For All", there are, for example, "Education International" and "Global Environmental Education Partnership (GEEP)". "These networks have the common aim to change education worldwide. However, they differ in terms of their geographical and content focus, their methods, and the

Photo: Thomas Roese

The **European Research Council (ERC)** supports excellent researchers and their teams with innovative and progressive project and research ideas in all fields of research. Projects are funded for up to five years with grants between 1.5 – 2.5 million euros. ERC funding is open-topic. The sole criterion for funding is excellence. The funded project has to be conducted at a scientific institution of the researchers' choice in Europe or one of the partner institutions.

key areas they focus on," she says. "Sometimes the focus is on climate education, for example, sometimes it's on human rights."

New methods for new networks

To be able to measure the "global non-governmental spaces" emerging in education, Prof. Kolleck has developed a new methodological approach. With the help of quantitative surveys, the researchers want to investigate the structure of the networks and what content they specifically deal with. They also collect extensive text data and data from social media platforms. This data is then analyzed both quantitatively and qualitatively in order to identify patterns, trends, and effects. The researchers primarily use natural language processing and social network analysis methods. "The social media data provide us with insights into public information, communication and influence flows, interactions between different actors, networks, discussions, and reactions," Kolleck explains. They are able to analyze both the structures of these interactions, i.e., the social network structures, as well as the content of the discourses and debates. "I believe that we will only be able to understand the changing significance of NGOs for the education sector if we combine both levels," she says.

Social media data has a decisive advantage: As so-called natural data, it is generated without the intervention of the researchers – in contrast to data from scientific surveys. Although not all relevant actors are represented on these platforms, it creates a good starting point for a valuable, complex longitudinal analysis. Large data sets covering a longer period and natural communication flows are thus analyzed using social network analysis methods. Prof. Kolleck sees enormous potential for her new interdisciplinary methodological approach. "I think that it will also be applicable in other policy and research areas in the future, such as health policy, global environmental policy, and human rights. That is why I want to use my project to show directly how beneficial it is to work in an interdisciplinary way, especially in such innovative fields."

As a first step, Kolleck hopes to be able to better explain the work of NGOs such as "Teach For All", so that it forms a precedent and "we can do something about growing global educational inequality."

LENA HIMMLER AND MATTHIAS ZIMMERMANN

Photo: AdobeStock/Mustafa

Improved Warning!

Researchers Examine 2021 Flooding Catastrophe From the Perspective of Those Affected

In July 2021, devastating floods caused by heavy rainfall occurred in Rhineland-Palatinate and North Rhine-Westphalia, and to some extent also in Saxony and Bavaria, with more than 180 fatalities. In the months that followed, a risk research team from the University of Potsdam studied how the population was informed about the events and how they were warned of the dangers. Their conclusion: Early warning systems in Germany urgently need to be improved – not only in terms of the dissemination of warnings, but also regarding clearer communication about the extent of the danger and recommendations for appropriate behavior. The results of their stakeholder survey have now been published as a highlight article in the EGU journal, Natural Hazards and Earth System Sciences.

"The existing severe weather and flood warning systems in Germany are not sufficient to effectively warn the population of rapid flooding," says the study's lead author, Prof. Annegret Thieken. "Future research should focus on how to use these systems to warn vulnerable communities and residents in a timely manner and better communicate the extent of flooding, the threats, and response options."

THE WHOLE REPORT

The Publication: Thieken, A. H., Bubeck, P., Heidenreich, A., von Keyserlingk, J., Dillenardt, L., and Otto, A.: Performance of the flood warning system in Germany in July 2021 – insights from affected residents, Nat. Hazards Earth Syst. Sci., 23, 973–990, https://doi.org/10.5194/nhess-23-973-2023

Dark pair

Massive touching stars will eventually collide as black holes

Two massive touching stars in a neighboring galaxy are on course to become black holes that will eventually collide, generating waves in the fabric of space-time, according to a new study by researchers at University College London and the University of Potsdam.

In the study, published in the journal "Astronomy & Astrophysics", the two early career researchers look at a known binary star, i.e. two stars orbiting around a mutual center of gravity, and analyze starlight obtained from a range of ground- and space-based telescopes. They found that the stars, located in a neighboring dwarf galaxy called the Small Magellanic Cloud, are in partial contact and swapping material with each other, with one star currently "feeding" off the other. They orbit each other every three days and are the most massive touching stars yet observed.

Comparing the results of their observations with theoretical models of binary stars' evolution, they expect that the star that is currently being fed on will become a black hole and will feed on its companion star. The surviving star will become a black hole shortly after. These black holes will form in only a couple of millions of years, but will then orbit each other for billions of years before colliding with such force that they will generate gravitational waves – ripples in the fabric of space-time.

THE WHOLE REPORT

The Publication: M. J. Rickard and D. Pauli, A low-metallicity massive contact binary undergoing slow Case A mass transfer: A detailed spectroscopic and orbital analysis of SSN 7 in NGC 346 in the SMC, Astronomy & Astrophysics, https://doi.org/10.1051/0004-6361/202346055

Binary star on course for black hole merger. The smaller, hotter star (left), which is 32 times the mass of our Sun, is currently losing mass to its bigger companion (right), which has 55 times the mass of our Sun.

Photos: AdobeStock/medienweber (li.); UCL / J. daSilva (re.)

Search and rescue operations do not seem to have an influence on the crossing attempts of migrants in the central Mediterranean Sea

The search for and rescue of boats transporting migrants across the central Mediterranean Sea does not seem to have any influence on the number of people starting the risky journey. This is the conclusion of a research team led by Potsdam social scientist Alejandra Rodríguez Sánchez, who analyzed data on attempted crossings between 2011 and 2020. It contradicts the often-made claim that the search and rescue operations themselves contribute to more people attempting the Mediterranean crossing – and thus increase their risk of death. Rather, the researchers' analysis suggests that migration across the central Mediterranean during this period was driven more by factors such as conflict, economic, or environmental conditions. The results of the modeling study have now been published in the journal Scientific Reports – Nature.

"Our modeling showed that the changes in the number of border crossings by sea did not seem to be influenced by the so-called search and rescue operations, suggesting that these do not provide an incentive for additional crossing attempts," says the study's lead author Alejandra Rodríguez Sánchez from the University of Potsdam.

THE WHOLE REPORT

The Publication: Alejandra Rodríguez Sánchez, Julian Wucherpfennig, Ramona Rischke, Stefano Maria Iacus: Search and rescue in the Central Mediterranean Route does not induce migration: Predictive modeling to answer causal queries in migration research, Nature Scientific Reports (2023), 13:110114, https://doi.org/10.1038/s41598-023-38119-4

Natural Carbon Reservoirs

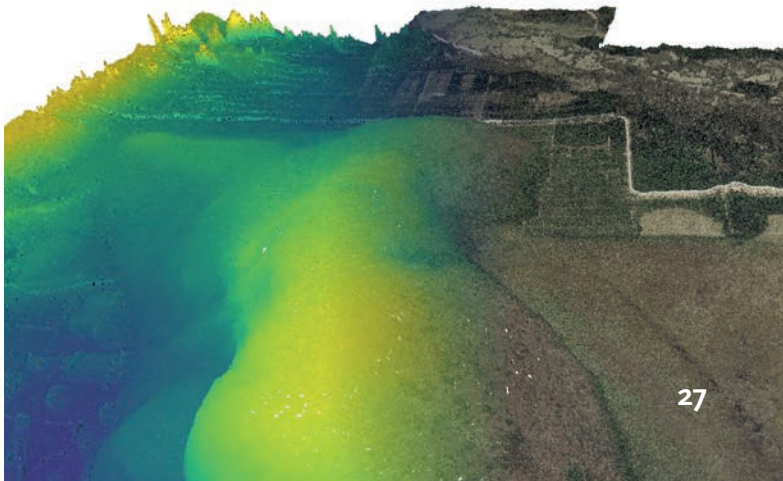
Peatlands worldwide measured from space

An international study examined the morphology, hydrology, and carbon storage of raised peatlands across diverse biomes – from Alaska, through the tropics, to New Zealand – with a remote sensing and modeling based approach. Remote sensing specialist Bodo Bookhagen, Professor at the University of Potsdam, participated in the research, which was recently published in the journal "Nature". The findings provide a basis for planning natural climate solutions by rewetting damaged bogs around the world.

"In this study, we have used high-resolution topographic measurements from airborne and spaceborne lidar systems to derive a unified model to combine peat surface shapes and peat dynamics," says Prof. Bookhagen. The approach makes it possible to infer the full shape of a bog from a sample of elevations, such as a single elevation transect. It builds upon earlier work where satellite and airborne lidar (light detecting and ranging) data have been used to characterize surface and vegetation characteristics in various ecosystems that were conducted in the Geological Remote Sensing group led by Bookhagen.

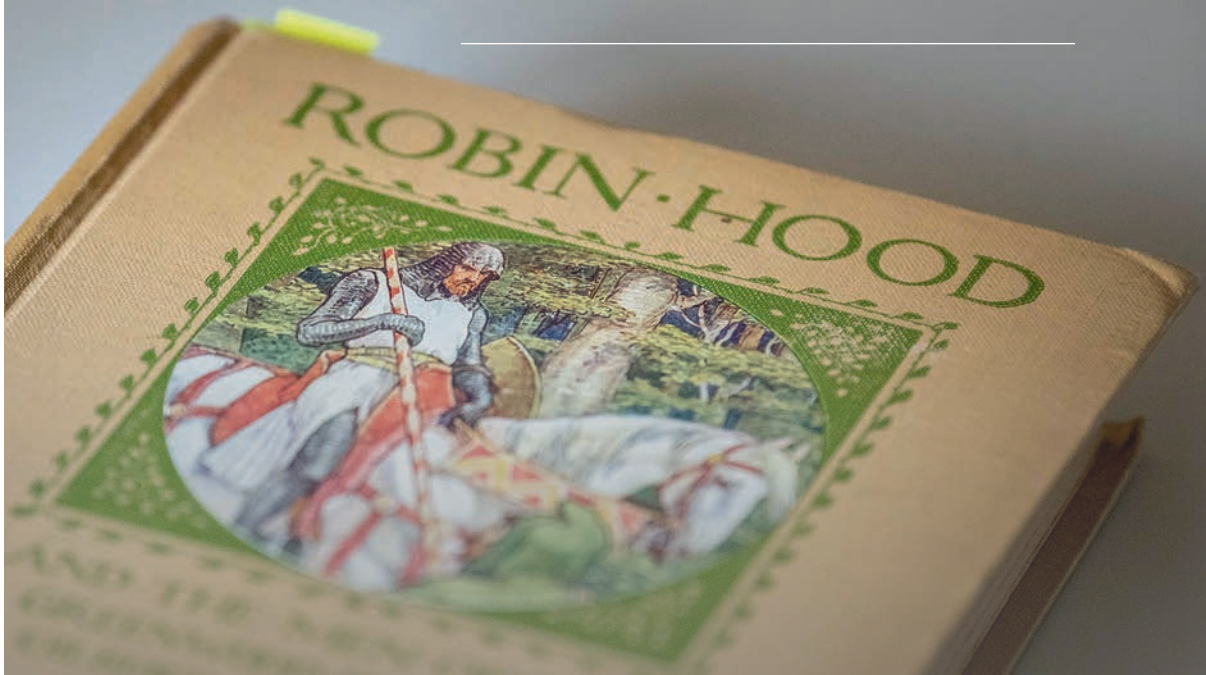
THE WHOLE REPORT

The Publication: Cobb, A.R., Dommain, R., Yeap, K., Hannan, C., Dadap, N.C., Bookhagen B., Glaser, P.H. & Harvey, C.F., A unified explanation for the morphology of raised peatlands, Nature (2023) https://doi.org/10.1038/s41586-023-06807-w



3D perspective from airborne lidar point clouds for the Valgeraba peat area in Estonia. The coloring indicates elevation (left side) and true surface colors from arial photos (right side). The elevation has been 50x vertically enlarged to show the peat morphology and shape.

Photos: AdobeStock/bluebeat76 (li.); Prof. Dr. Bodo Bookhagen (re.)



… that kings and peasants dressed up as Robin Hood?

Bow and arrow, green clothing with a hood. That can only be Robin Hood, can't it? In fact, the stories about the outlaw in the Sherwood Forest were so popular in the 15th and 16th century that people – regardless of their status – enjoyed slipping into his role. Even Henry VIII. was among his fans and "changed" into the character twice, according to historical reports. In Robin Hood plays, the population also played the outlaw in the late Middle Ages, at festive processions or in theater performances. Some people gave themselves the nickname "Robinhood" from as early as 1250. Even though it is unclear which event triggered the hype surrounding the "avenger of the oppressed", he undoubtedly fascinated many people, a fascination that continues to have an effect to this day.

Potsdam specialist in German studies PD Dr. Judith Klinger could not resist him either – as a researcher, of course. She wrote one of the first German-language introductions to Robin Hood. Her academic interest in the English outlaw was sparked during her studies when the TV series "Robin of Sherwood" by Richard Carpenter was broadcast. "It was a very clever, historically well-researched TV series remarkably close to the medieval texts. The special thing about it was that Robin Hood was not a person but a role." After all, he is also known to his fans as a master of masquerade.

Klinger considers the dressing up to be one of the things that make Robin Hood so appealing and thus justifies his special position outside the order. He is sometimes a merchant, sometimes a clergyman, a bounty hunter, or an old woman when he goes out into the world beyond Sherwood Forest. In doing so, he crosses borders unrecognized. "Robin's identity consists of spatial and social mobility. This challenges the status society with something radical because he takes on roles that are otherwise only innate or inherited," Klinger says.

Besides the masquerade, the master archer settled in a characteristic place – the forest. In the Middle Ages, this was a complex space legally, socially, and economically, but it was also associated with mythical

Photo: Thomas Roese

notions of an impenetrable place outside society. "The forest, in its primeval, earthy nature, makes Robin Hood a representative of the order that is visible in nature and that stands against the culturally created civilizing order," Klinger says. Robin appears as an alternative king of the forest, in contrast to the real regent, who rules over the forest of reality by royal forest law. The "Greenwood" is portrayed as a paradisiacal place of eternal summer, as an antithesis to medieval reality. The texts did not show the burdensome life as an outlaw and outsider, for example in winter.

Robin Hood, however, would be nothing without his companions! The ingrained community of the "merry men" impresses the readers with their virtues of faithfulness and loyalty. "Of course, there are fervid confrontations, but as soon as a conflict from outside is threatening them, they overcome their differences," Klinger says. With each new story about the outlaw, more of his equally iconic companions join him. First it is "Little John", later "Much, the Miller's Son" and "Friar Tuck". The companions live the ideal of a just community outside of the law, of common hierarchies, and kinship systems. Originally, it was also a homosocial community, as Dr. Klinger explains, because "Maid Marian" was not part of the stories' core group from the very beginning. Her character only emerged when the Robin Hood performances were introduced at the May Games. In the stories about Robin, she is a bridge figure to the May Queen of the Games.

THE RESEARCHER

PD Dr. Judith Klinger has been research assistant and lecturer at the Chair for German Medieval Studies of the Department for German Literature and Language since 1995. She completed her habilitation here in 2017.

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Photos: Thomas Roese (li.); Public Domain (re.)

Dr. Judith Klinger

FURTHER READING

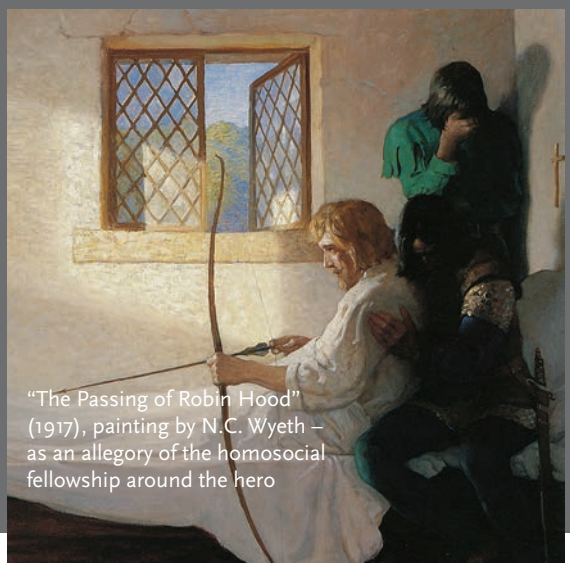
Judith Klinger: Robin Hood: Auf der Suche nach einer Legende (In Search of a Legend), Darmstadt 2015

"It is quite interesting that Marian was played by men in the theater performances. In a text from the 17th century, when she enters the stage for the first time, she is disguised as a page and thus part of the homosocial pattern," Klinger explains.

As the noblest of robbers, Robin Hood combines a number of qualities that have attracted people throughout the ages. Because the law is not always fair, he takes it into his own hands and ensures justice. But: "The fact that Robin takes from the rich and gives to the poor was only added to the story later," she says. And something else only developed over time: Robin Hood was not yet a noble in the earliest texts. It was not until the end of the 16th century that playwright Anthony Munday turned him into a nobleman. According to Klinger, this change was not surprising as the character embodied many noble values. "It was only a small step to declare him a nobleman who had experienced injustice and had to retreat into the woods for a while. This actually happened many times in reality: Nobles who were ostracized for whatever reason, moved into the woods, and later returned."

There are many reasons why Robin Hood is so popular. But who was he, and where did he come from? Some historians are still searching for a historical role model. Others consider the stories about him to be pure fiction. Dr. Klinger, on the other hand, suggests, "We should rather examine the historical events and the environment to find out what in the stories corresponds to the historical circumstances." The truth is: "The early Robin Hood has no verifiable origin." He is story material and fulfills certain needs. The significance he has for enthusiastic Robin Hood fans is clear: He fascinates them and has done so for generations.

LUISA AGROFYLAX



"The Passing of Robin Hood" (1917), painting by N.C. Wyeth – as an allegory of the homosocial fellowship around the hero

The Collaborative Indo-German Project Co-PREPARE

DR. JÜRGEN MEY,
UNIVERSITY OF POTSDAM

Co-PREPARE – What is it about?

The project deals with natural hazards in the Himalayas. The challenges of global change come together in this region. On the one hand, receding glaciers and permafrost are affecting the availability of water during the dry season in the medium term. On the other hand, the warming of the atmosphere is leading to more frequent weather extremes such as flash floods and landslides. This collides with rapid economic development and the concomitant expansion of transportation and energy infrastructure.

What is the aim of the cooperation?

We are pursuing three goals: firstly, to strengthen the internationalization of both institutions through exchanges of students, researchers, and staff of the international relations departments; secondly, to jointly investigate extreme hydrometeorological events and their impact on the population; and thirdly, to transfer knowledge between the partners and to the public.

How does the cooperation in the project work in concrete terms – especially in view of the great distance?

The collaboration essentially works through constant exchange via emails, phone calls, and video conferences. Since the time difference is only four and a half and three and a half hours, respectively, our working hours overlap sufficiently.

Where and how does the research come into practice?

In addition to the publication of the scientific results, which can become the basis for political decisions, it is an important task to raise awareness among the local population. Therefore, teams from the Indian Institute of Technology conduct workshops in particularly exposed communities. In addition, we offer an online lecture series that is available to the public via the project website.

↗ Scan to read more about Co-PREPARE

Photos: Till Francke (Hintergrund); Wolfgang Schwanghart

Photo: Saurabh Vijay

PROF. ANKIT AGARWAL, INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

CoPrepare – what is it about?

The Co-PREPARE project, focuses on natural hazards in the Himalayan Region. This endeavor aims to enhance joint hazard research capacity by pooling expertise, methods, and data to comprehend impacts and changes in the Himalayas and beyond. This cooperative effort involves research, scientific work, and training commitments.

What is the aim of the cooperation?

The project aims at strengthening institutional internationalization, fostering collaborative research, and generating actionable knowledge. Co-PREPARE promotes internationalization through staff exchanges and administrative initiatives. Emphasizing sustainable cooperation, it seeks to amalgamate expertise and resources, focusing on scientific work and training to deepen the understanding of the region's hazards.

How does the cooperation in the project work in concrete terms – especially in view of the great distance?

Despite vast distances, Co-PREPARE's cooperation transcends boundaries, extending into institutional and diplomatic realms. Amid COVID-19 challenges, our accomplishments exceeded projections due to consistent meetings, information exchanges, and unwavering administrative support.

How and where does the research come into practice?

We contribute studies that highlight the risks associated with hydropower expansion and tourism-related development, which is crucial for policy planning and disaster mitigation. Furthermore, we integrate local knowledge by following a participatory approach that not just contributes to disaster-resilient planning and sustainable development but also ensures the acceptance of stakeholders.

THE PROJECT

Co-PREPARE – Indo-German Joint Project on Natural Risk Assessment and Forecasting in the Himalayan Region

Funding: DAAD (Deutscher Akademischer Austauschdienst) / UGC (University Grants Commission – India)
Duration: 07/2020-06/2024
Involved: University of Potsdam; Cooperation partners: Indian Institute of Technology, Roorkee (Indien); Potsdam Institut für Klimafolgenforschung; Deutsches Geo-ForschungsZentrum GFZ; National Institute of Hydrology (Indien); Central Building Research Institute (Indien); Wadia Institute for Himalayan Geology (Indien)

Photo: AdobeStock/Fox Bread

“We are bridging a gap that cannot yet be closed in the lab”

Zoran Nikoloski about the world of bioinformatics

Biology is the scientific research of life, and computer science is the art of automatic information processing. Does that go together? Absolutely! Bioinformatics has been in the limelight since at least the first extensive sequencing of the human genome in 2003. After all, it played a major role in the “decoding” of human DNA. As a science at the interface between biology and computer science, it combines the principles and technological possibilities of both worlds to get to the bottom of topical issues. How does the highly complex metabolism of plants, animals, and humans work? How can crops be optimized, for example to make them more resistant to heat? And can our knowledge of the metabolism of bacteria be used to turn them into tiny biological factories? Matthias Zimmermann talked to bioinformatics specialist Prof. Dr. Zoran Nikoloski about old and new scientific questions, complex networks and their modelling as well as research results that are suitable for practical implementations.

You are Professor of Bioinformatics. What do you research?

Traditional computer science tries to solve general problems in society with the help of computers. Transferring this principle to biology, I would say that we deal with biological problems that we tackle with the help of computers. And there are many such problems, for example understanding the structure and function of protein complexes or modeling the processes in metabolic networks. In fact, the field offers endless possibilities, with which it has continued to grow. Classical bioinformatics began with the retrospectively simple task of deciphering the DNA code. The starting point was basically the project of identifying genes in DNA strands, which is nothing more than a sequence of letters.

The emergence of so-called OMICS technologies and other technological possibilities to analyze organisms at the molecular level then provided us with an enormous flood of data – terabytes of data on various levels of organisms! This led to the question of how we could use this data in a meaningful way, for example to understand which mechanisms underlie cellular processes. And, subsequently, how can the data help us to recognize things that have not been measured themselves or are not measurable at all? To a certain extent, the latter describes the second wave of bioinformatics, combined with the paradigm of systems biology.

OMICS TECHNOLOGIES

Omics technologies are derived from the suffix ‘omic’, which marks subfields of modern biology that engage in the analysis of collectivities of similar individual elements. This includes, for example, genomics, which looks at the genes of an organism, proteomics, which researches proteins, and metabolomics, which examines metabolic networks.

Do people who pursue bioinformatics tend to come from the field of computer science or biology?

Those who started out in bioinformatics 40 years ago definitely came from computer science because the questions they were dealing with were very much driven by computer science. But the more closely the problems were connected with biology, the more biologists joined. At the moment it’s quite balanced. However, I believe that with the further development of AI tools that help break down technical barriers, more and more ‘pure’ biologists will switch to bioinformatics.

Prof. Zoran Nikoloski

THE RESEARCHER

Prof. Dr. Zoran Nikoloski is group leader of the research group "Mathematical Modelling and Systems Biology" at the Max Planck Institute for Molecular Plant Physiology and, since 2017, Professor of Bioinformatics at the University of Potsdam.

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Which specialist area do you come from?

Computer science and applied mathematics, particularly graph / network theory. I came to biology through my interest in the spread of diseases via networks. I investigated how the structures of a network enable or prevent, accelerate or slow down the spreading of agents. It doesn't matter what the agent actually is: a pathogen or a messenger substance, a neurotransmitter, or an animal. I realized that research into networks is important for many areas of science and that the results can be widely applied. Since then, I have intensively worked on analyzing cellular networks and the question of how they interact with each other.

So biology benefits from the concepts of computer science here. What about the other way around?

About 20 years ago, there was a major shift towards biologically inspired design, which aims to imitate or transfer biological principles to improve computer science. A typical example are algorithms based on the concept of mutation and evolution. We are currently seeing that the knowledge we have gained about networks, especially from biological networks, is being transferred to the synthetic field. Indeed, in synthetic biology, new systems are being developed that are based on fundamental biological principles. Like a bridge in the other direction.

Your research ranges from computational biology and bioinformatics to systems biology. Can you explain the differences?

In computational biology, we try to describe and simulate biological systems mechanistically in order to replicate and predict certain phenotypes. Bioinformatics is about relating genotypes to phenotypes, understanding how DNA modifications influence certain characteristics, how proteins are structured or function. And in systems biology, we look at the organism as a combination of many different systems, for example gene regulation networks, protein-protein interaction networks, and metabolic networks. We try to understand how these networks influence certain traits, processes, and dynamics of the system, especially those that we cannot see and measure. So we can say that the three areas build on each other: from mechanistic simulation to mapping genotypes to phenotypes to understanding how these different systems interact and generate higher parts of the system that are not necessarily observed.

METABOLIC NETWORKS

Metabolism describes all chemical transformations of substances in the bodies of living beings into intermediary products (metabolites) and end products. Metabolism, after all, is a complex network of individual reactions that determine and influence each other.

Photos: Thomas Roese (2)

Your work focuses on so-called metabolic networks. How can you research these highly complex systems at all?

All research into metabolic networks begins with the genome, i.e., the sequenced genetic material of an organism. Thanks to 100 years of biochemistry, genes and their effects are relatively well researched for some plants and microorganisms. We know what these genes do, what kind of proteins they form and what reactions these proteins catalyze. This knowledge, the entire catalog of known enzymatic reactions, is available in large biochemical databases. For our research, we take this information from the databases and combine it into networks – not as a pretty drawing on a whiteboard but as a matrix. With this matrix, a representation of the networks in our studied organism, we can calculate what is happening in it and make predictions because we can link data that has been measured for individual processes and simulate what cannot be measured. In this way, we bridge a gap in the model – between structure and function – that cannot yet be closed in the laboratory.

This also enables predictions about more complex traits such as growth, yield, disease progression, and reactions to changes in the environment. The long-term goal is, of course, to know where and how to intervene in the metabolic network in order to obtain an organism with the desired trait.

Which organisms do you work with?

We work with microorganisms, such as yeast, model algae and plants, such as corn, rice, and tomatoes. We also research human metabolism and different types of cancer cells.

Why so many different organisms?

By working with very different organisms, we are able to identify universal design principles that are then widely applicable in synthetic biology. Our models show that metabolic networks are organized similarly across a wide variety of organisms. Accordingly, our approaches to developing genotypes that perform certain tasks better can ultimately be used in a variety of ways.

Would you describe your research as basic or applied research?

That depends on the project. Some things, such as the analysis and description of metabolic networks, requires years of theoretical work before concrete applications can even be considered. Research on the

THE PROJECTS

PlantaSYST

The overall objective of **PlantaSYST** is to establish a Center for Plant Systems Biology and Biotechnology (CPSBB) in Plovdiv, Bulgaria.

Participants: Center of Plant Systems Biology and Biotechnology (CPSBB); Maritsa Vegetable Crops Research Institute (MVCRI); Institute of Microbiology, Laboratory of Metabolomics, all Bulgaria; Max Planck Institute for Molecular Plant Physiology; University of Potsdam
Funding: European Union / HORIZON 2020
Duration: 2017–2025

↗ Scan to read more about the project

RESIST

The main objective of **"RESIST"** is to decipher the genetic determinants of desiccation tolerance in resurrection plants and to identify similarities and differences to model and crop species. The knowledge will then be transferred to economically important species.

Participants: Center of Plant Systems Biology and Biotechnology (CPSBB), Bulgaria (coordination); Max Planck Institute for Molecular Plant Physiology; University of Potsdam; Ben-Gurion University of the Negev (BGU), Israel; BioAtlantis Ltd., Ireland; University of Cape Town (UCT), South Africa
Funding: European Union / HORIZON 2020
Duration: 2020–2024

↗ Scan to read more about the project

ALPHAFUELS

Funding: European Union / Horizon Europe
Duration: 2024–2027

C3 AND C4 PLANTS

During the photosynthesis of **C3 plants,** carbon dioxide is being absorbed into chemical components with three carbon atoms. During hot or dry, their photosynthetic performance is reduced as the stomata close to prevent excessive evaporation of water. They are most efficient under moderate light conditions and temperatures between 15 and 25 degrees Celsius. **C4 plants,** on the other hand, reach their optimal photosynthetic performance between 30 and 47 degrees Celsius and are more resistant to heat and drought. C3 crop plants include, for example, wheat, rye, barley, oat, potatoes, soybeans, hemp, and rice as well as all tree species worldwide. C4 plants include, for example, corn, sugar cane, and millet.

development of cell factories can also have immediate practical applications, with results that can be used in industry within a year. Theoretical research on the robustness and plasticity of organisms might not be directly transferable, but it creates knowledge whose value may only become apparent later.

How is that?

I think the most interesting question that we have pursued so far is, for instance, how we can use the knowledge about the natural metabolic variability in order to predict the behavior of genotypes and populations. Why is this important? Because when I have models for the natural adaptability of organisms, I can use the designs available in nature to create a new genotype that will perform better at a certain task. It might be more efficient at photosynthesis, for example. For this purpose, we compared the natural variability of a typical C3 plant like barley with a photosynthetically more efficient C4 plant like corn. For both, we created comprehensive models on their photosynthetic activity. This enabled us to identify the actual differences in the DNA of both plants, which are responsible for the differences in their photosynthetic efficiency. This knowledge can now be used in a variety of ways. For example, the properties of the responsible enzyme can be improved in the lab because we know what needs to be changed. In fact, we just started a follow-up project with the University of Cambridge in December 2023, based on this basic research, in which we repeat this analysis with even more organisms and take first steps in bioengineering.

What else are you currently researching?

The project "RESIST", for example, brings together partners from South Africa, Israel, Ireland, Bulgaria, and Germany. We are looking at so-called resurrection plants and their unique abilities to withstand droughts and continue to be able to survive even after months or years without any water. If we find out how this variability of their metabolic networks comes about, we can transfer it to other plants and develop drought resistant cultures.

A very application-oriented project …

Just like our project "ALFAFUELS", which we only launched on January 1, 2024, and in which we try to obtain aviation fuel from cyanobacteria. During the first year, my group will be involved in the design of strategies to create precursor substances for jet fuel, which will then be developed and tested in the second year. In the third year, everything will be optimized for industrial application. So the path from the lab to practice is quite short in this case.

THE INTERVIEW WAS CONDUCTED BY MATTHIAS ZIMMERMANN.

Photo: AdobeStock/PanuApril

University of Potsdam Takes Third Place Again in National Startup Ranking

The University of Potsdam again won third place in this year's Germany-wide Startup Radar, which is run by the Stifterverband, a joint initiative started by companies and foundations. The UP thus held its own in the category of "large universities" with over 15,000 students. This places our university directly behind the University of Applied Sciences in Munich and Saarland University. In the metropolitan region of Berlin-Brandenburg, the University of Potsdam even ranks first. "The University of Potsdam is proud to have developed into one of Germany's best universities for startups over the past 30 years. We will continue to contribute significantly to making the metropolitan region one of the most successful regions, at the international level, for generating startups," says University President Oliver Günther.

↗ Scan to read the press release

University of Potsdam reaches Second Place in University Ranking for Equal Opportunities

For the first time, the University of Potsdam has been ranked second in this year's university ranking for equal opportunities. Getting from third to second place represents a further improvement. Together with the EBS University of Business and Law in Wiesbaden, it forms the top group. The ranking is published by the Competence Center for Women in Science and Research (CEWS) and is an established quality assurance tool for gender equality at universities.

↗ Scan to read the press release

In High International Demand – University of Potsdam among Top 15 in New Humboldt Ranking

The University of Potsdam is held in high regard by researchers from abroad. This is the result of the current, revised Humboldt Ranking, in which it was ranked 14th among the 127 ranked universities, achieving a very good position among the most popular German universities. The ranking shows how many academics have come to Germany in the past five years thanks to funding from the Alexander von Humboldt Foundation, as well as the institutions where the greatest numbers of these researchers spent their research stays. During this period, 63 researchers worked at the University of Potsdam with a fellowship or award from the foundation.

↗ Scan to read the press release

University of Potsdam Once More in Group 201–250 in THE Ranking of Best Universities Worldwide. Even Among the Best of Young Universities in Germany

In the current 20th edition of the renowned "Times Higher Education" (THE) ranking, the University of Potsdam was able to retain its top position from the previous year. Ranked in the 201–250 group, it occupies an excellent position in the field of the 1,904 ranked universities from 108 countries worldwide. In the THE U 50 ranking for universities under 50 years of age, the University of Potsdam even achieved a better ranking than in the previous year. With a total of 600 ranked universities from 104 countries, the University of Potsdam was among the top 22 worldwide and ranked 1st within Germany.

↗ Scan to read the press release

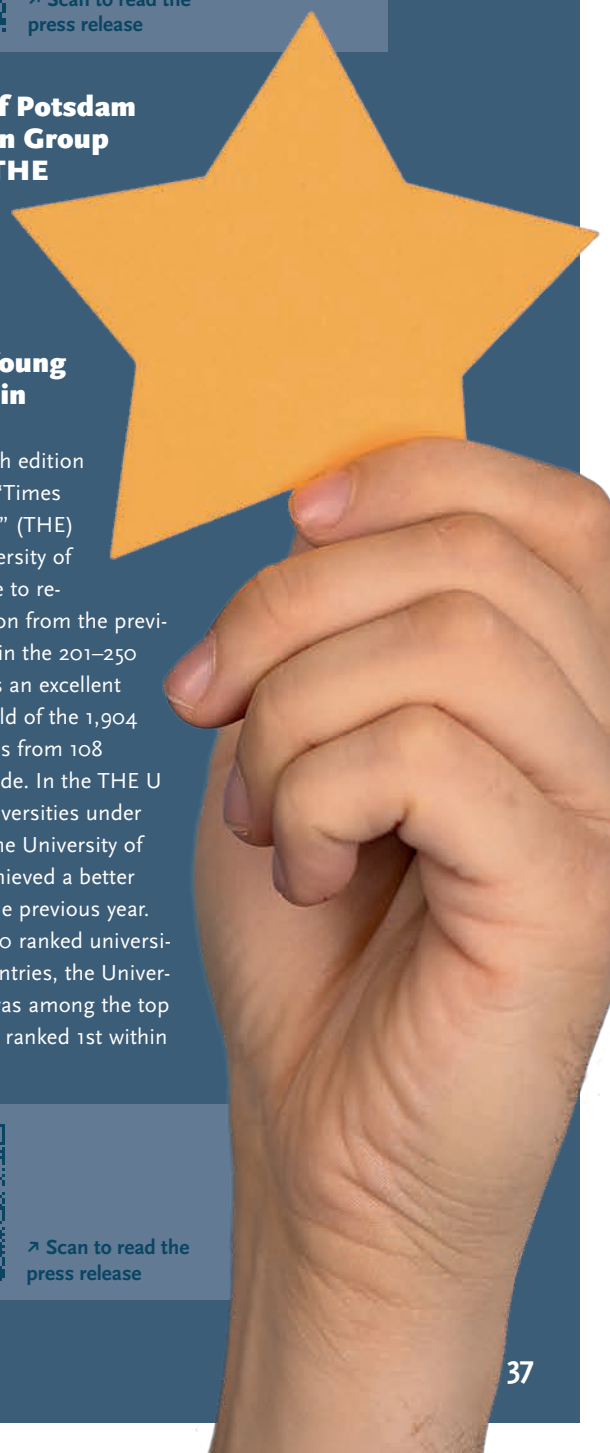

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Photo: AdobeStock/Sebastian

From Very Old Deposits to Active Underwater Volcanos

Geoscience Researchers Study the Formation of Ore Deposits

In the DFG Priority Program DOME, it is all about ore: How are mixtures of different minerals and metals formed, which have very different properties depending on their composition? How can one better find, mine, and process deposits? In search of answers to these and other questions, numerous research teams from all over Germany are traveling the world – from the mountains to the seabed, from China to Canada.

The highest mountain is only 1,214 meters high. Although the small Ore Mountains cannot compete with the mighty mountain ranges of the world, they boast other qualities that are reflected in their name. The mountain formation is several hundred million years old and is considered the cradle of numerous mineral resources such as silver, tin, tungsten, and iron. Important geological processes, which have created numerous important deposits of various ores, can be studied here in a comparatively small area.

A look into the history of the Earth

The mountains are therefore a veritable open-air laboratory that is practically on the doorstep for geoscientists from Germany. In summer 2021, around 30 researchers and doctoral students took the opportunity to spend five days exploring what can be found above and below ground. Most of them had just started research projects in the large-scale research program "Dynamics of Ore Metals Enrichment" (DOME). The excursion was a prelude and a belated opportunity to

THE PROJECT

The Priority Program **"Dynamics of Ore Metals Enrichment" (DOME) (SPP 2238)** is funded by the German Research Foundation (DFG). The research projects investigate the dynamics of ore-metals enrichment in nature. With the help of empirical field studies, experimental work, and numerical process modeling, the researchers are creating new foundations for the exploration of deposits in deep layers of earth.

Duration: 2020–2026
Participants: University of Potsdam, Universität Bayreuth, University of Bremen, Leibniz University Hannover, Johannes Gutenberg University Mainz, GeoZentrum Nordbayern, Friedrich-Alexander Universität Erlangen-Nürnberg, TU Bergakademie Freiberg, GEOMAR Kiel, Goethe University Frankfurt (M), University of Freiburg, RWTH Aachen, University of Tübingen, The Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, University of Cologne, University of Münster, Karlsruhe Institute of Technology, Helmholtz-Institute Freiberg for Resource Technology.
Funding: German Research Foundation (DFG)

↗ Scan to read more about the project

Dr. Maximilian Korges

Prof. Max Wilke

THE RESEARCHERS

Prof. Dr. Max Wilke has been group leader of the working group Mineralogy at the Institute for Geosciences of the University of Potsdam since 2015.

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Dr. Maximilian Korges has been a Postdoctoral Researcher in the working group Mineralogy at the Institute for Geosciences of the University of Potsdam since 2020.

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get to know each other: it had actually been planned a year earlier but had to be postponed due to the Corona pandemic.

"In the Ore Mountains, you can walk from the center of the former magma chamber up to the former surface of the earth within a day," explains the coordinator of the priority program, geoscientist Maximilian Korges. The geologically most interesting spots are where the magma chamber meets the surrounding rock: This is where many different ore minerals formed over millions of years. Seeing the rock structures and formations with your own eyes is highly informative, especially for those who usually work in a lab or at a desk. "It is particularly valuable for young researchers to look beyond their own horizons and gain skills outside their own field of work," Korges emphasizes.

Three years and 50 publications

DOME started in 2020 with 26 research projects involving institutes from all over Germany. "First of all, it's about understanding how ores form," explains DOME spokesperson Max Wilke, Professor of Mineralogy. "This has not been done in this way in Germany or anywhere else for a very long time." However, basic research also provides important findings for later application – i.e. the development of new ore deposits and their extraction. "Then you know where to look or what data you need in order to find new deposits," Prof. Wilke sums up.

The researcher looks back on the positive developments of the past three years. "We have already published 50 papers resulting from our projects although many of them have not even been completed yet. And we have been successfully networking both nationally and internationally." In order to train and promote young researchers, the DOME research network not only offers field-related studies but also workshops on experimental methods and mathematical modeling, seminars on presentation techniques, or on writing a scientific publication.

"All German universities and research institutions in our field of research are represented with projects in DOME," Prof. Wilke is happy to report. The research projects represent an immense variety of special fields and are conducted all over the world: from Germany, Portugal, China, Poland, Greece, Finland, the USA, Namibia, Brazil, Canada to the world's oceans. The

Photos: Sandra Scholz (2)

methods are as diverse as the places of research and include experiments in the laboratory, field studies and expeditions as well as computer modelling.

New projects for the second funding period

In Potsdam, for example, laboratory experiments are being conducted to investigate how molybdenum minerals behave in hot aqueous solutions. How much molybdenum, which is mainly used for steel production, dissolves at what pressure and temperature? In what condition is it present in the solution, and which parameters influence these processes? The researchers want to use the experiments to get a better understanding of the conditions under which these minerals are formed. This will make it easier to identify areas around the world with similar properties and potential molybdenum deposits. The chemical experiments also reveal how to better dissolve the material and separate individual metals in the ore mixture. In the future, the findings may also help to better process ores or make the metals usable again through subsequent recycling.

A doctoral student from Erlangen took part in a two-month research cruise and analyzed samples from underwater volcanoes to investigate mineralization processes at hot springs on the seabed, where boiling liquids, magmatic gases, and cold seawater meet. In the Ore Mountains, on the other hand, the researchers carry out field tests to understand the formation of tin ores. Numerical simulations help to model and understand the processes that take place in the magma chamber and the surrounding area over millions of years. "We can see the final product in the form of ore, but we don't know what happened before. Computer simulations can help us to take a look into the past," Korges explains.

The DOME project has now entered its second funding period until 2026 with 26 new projects and new research teams. The two project leaders from Potsdam agree that this field of research is likely to become increasingly important in the next decades because the global demand for many valuable elements found in ores, such as germanium, lithium, copper, and cobalt, will increase. After all, they are indispensable for key technologies in energy transition and digitalization. At the same time, geopolitical crises are exacerbating supply uncertainties. This makes it all the more important to strengthen research in this field in the coming years, train young researchers, and improve networking within the community.

HEIKE KAMPE

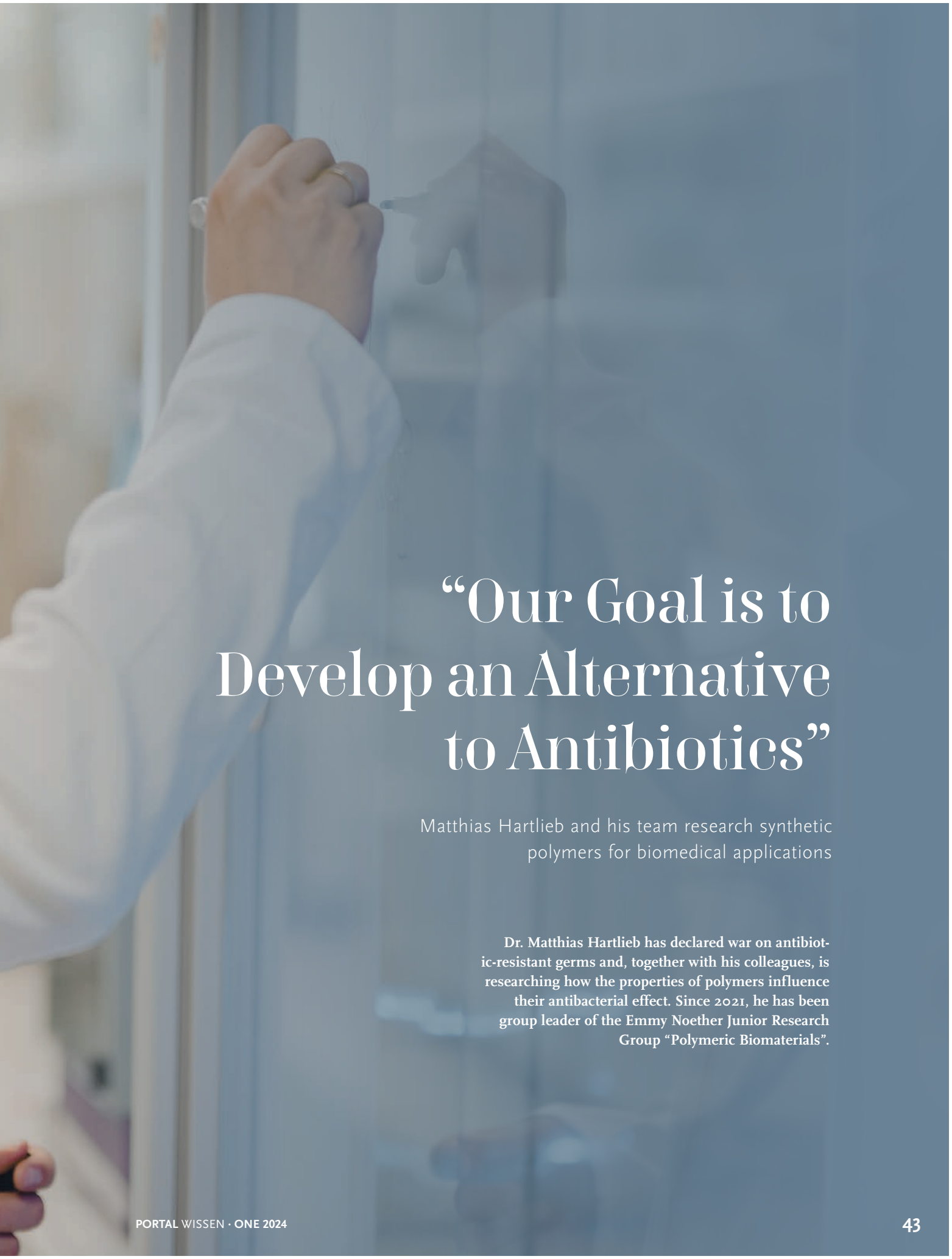
MOLYBDENUM

The **transition metal molybdenum** is found in various ores such as molybdenum disulfide (molybdenum glance), wulfenite (yellow lead ore) or powellite (calcium molybdate). In complex chemical processes, the molybdenum is separated from the accompanying minerals, then roasted at high temperatures of several hundred degrees Celsius, freed from further impurities, and reduced to molybdenum powder with the help of hydrogen in two further processing stages. In 2020, 240,000 tons of molybdenum, which is mainly used for metal alloys and in steel production, were produced worldwide.

Photo: Sandra Scholz

Dr. Matthias Hartlieb

Photo: Kevin Ryl



“Our Goal is to Develop an Alternative to Antibiotics”

Matthias Hartlieb and his team research synthetic polymers for biomedical applications

Dr. Matthias Hartlieb has declared war on antibiotic-resistant germs and, together with his colleagues, is researching how the properties of polymers influence their antibacterial effect. Since 2021, he has been group leader of the Emmy Noether Junior Research Group “Polymeric Biomaterials”.

THE RESEARCHER

Dr. Matthias Hartlieb has been group leader of the Emmy Noether Junior Research Group "Polymeric Biomaterials" at the University of Potsdam since 2021.

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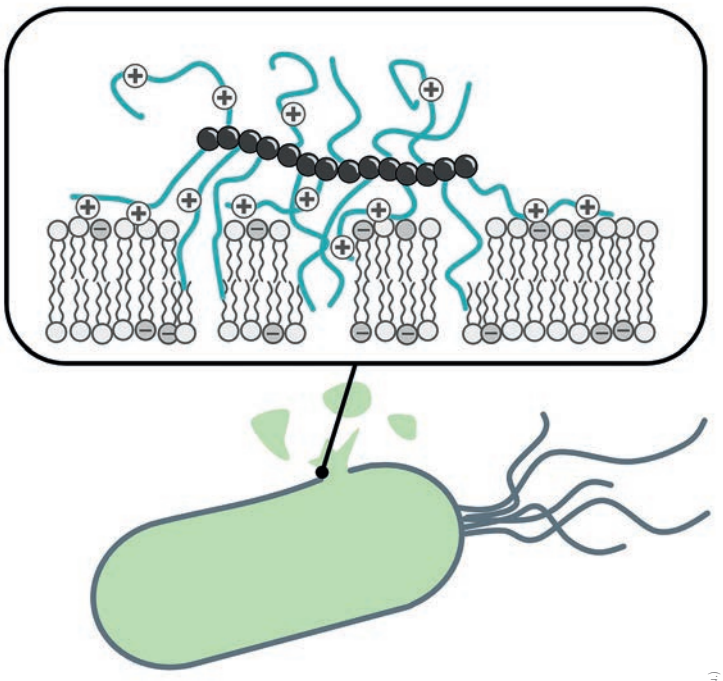
The World Health Organization (WHO) sees the rapid development of antibiotic-resistant germs as one of the ten greatest global threats to human health. "Bacteria and fungi have carried resistance genes since prehistoric times," Hartlieb says. The frequent use of antibiotics, however, creates an environment in which mainly resistant bacteria can survive and therefore spread more easily." They primarily occur where a lot of antibiotics are used – for example in hospitals or in lifestock farming – and get into the environment via wastewater. Every year, over 1.2 million people worldwide die from antibiotic-resistant germs. People with a weak immune system, transplanted patients, cancer patients undergoing chemotherapy, or patients undergoing surgery are particularly at risk of infection.

Bottlebrush polymers as antibiotics

"Our vision is to develop synthetic, water-soluble polymers that can be used in treating bacterial infections in humans in the same ways as we now use antibiotics, for example as tablets or injections," Hartlieb says. Since these polymers attack the bacterial membrane, bacteria can hardly develop any resistance to them. "They have properties that are also found in antimicrobial peptides, which our immune system uses to regulate and ward off bacteria," he adds. The peptides or polymers carry positive charges and can attach to the cell membrane of the bacteria, which is negatively charged.

Polymers are long molecular chains that consist of many identical parts. We know them, for example, as plastics such as polyester or polyethylene. In nature, they occur as carbohydrates such as cellulose and starch in plants or as proteins in cells. However, as simple long molecular chains, the polymers from Hartlieb's laboratory do not produce any significant effect on bacterial cell membranes. A lot of basic research is still needed to improve their antibacterial effect so as to be able to use them in therapy. "We work with so-called bottlebrush polymers, each individual bristle of which represents a polymer," he explains. This special architecture bundles many polymers in a small space, which then can attack the membrane of the bacterium more effectively.



Bottlebrush polymer is attacking a bacterial cell and destroying its membrane

Photos: Kevin Ryl (o.); Dr. Matthias Hartlieb (u.)

In the lab

THE PROJECT

"Next Generation Antimicrobial Polymers" has been funded by the German Research Foundation (DFG) as part of the Emmy Noether Junior Research Group since 2021. The second funding period has been approved recently and will start in 2024.

Participants: University of Potsdam
Funding: German Research Foundation (DFG)
Duration: 01/2021–12/2026

↗ Scan to read more about the project

Activity and selectivity of the polymers are decisive

An essential finding of the first funding period is that the structure of the used polymers strongly influences their bioactivity and selectivity. The activity quantifies the antimicrobial effect of the polymer, while the selectivity is a measure of how well it can differentiate between bacteria and body cells. The selectivity of a conventional antibiotic is very high. "That's our benchmark," Hartlieb emphasizes. To this end, the researchers are systematically testing different lengths and shapes of the brush polymers. For the bacterial tests, the group is cooperating with the Fraunhofer Institutes for Cell Therapy and Immunology (IZI-BB) and for Applied Polymer Research (IAP) in Golm.

Hartlieb and his team first want to find out how much polymer is needed to stop the growth of bacteria. The rule is: the less, the better. "We varied the architecture of the brush polymers until we found the optimum aspect ratio of the brushes," he explains. This made it possible to increase the selectivity from originally 32 to a value of 640, which means that the polymer is 640 times more effective against bacteria than against mammalian cells. "But there's more to it," he is sure.

In collaboration with the Charité Berlin, the antibacterial polymers from the laboratory in Potsdam will soon be tested on animals. "Another focus during the second funding period will be biofilms that can form in wounds or on implants where bacteria are more difficult to combat," Hartlieb summarizes. The promising results from the first funding period are good prerequisites for further steps towards an antibiotics alternative.

DR. STEFANIE MIKULLA

FURTHER READING

Publications about this topic by the Hartlieb Group

A.-C. Lehnen, S. Kogikoski Jr., T. Stensitzki, A. AlSawaf, A. Bapolisi, M. Wolff, J. De Breuck, H. Müller-Werkmeister, S. Chiantia, I. Bald, M. N. Leiske, M. Hartlieb, "Anisotropy in Antimicrobial Bottle Brush Copolymers and its Influence on Biological Activity" Adv. Funct. Mater, 2023, 2312651, https://doi.org/10.1002/adfm.202312651

A. M. Bapolisi, P. Kielb, M. Bekir, A.-C. Lehnen, C. Radon, S. Laroque, P. Wendler, H. M. Müller- Werkmeister, M. Hartlieb, "Antimicrobial Polymers of Linear and Bottlebrush Architecture: Probing the Membrane Interaction and Physicochemical Properties", Macro. Rapid Comm., 2022, 43, https://doi.org/10.1002/marc.202200288

Photos: Kevin Ryl (2)

FROM THE LAB TO INDUSTRY

The chemists Sebastian Zimmermann and Aaron Justin Koenig transfer the measurement technology of photon density wave spectroscopy into application in the innoFSPEC Transfer Lab

The Innovation Center innoFSPEC (innovative faseroptische Spektroskopie und Sensorik) was created as a joint venture of the University of Potsdam and the Leibniz Institute for Astrophysics Potsdam in 2008. Its goal: to establish interdisciplinary photonic research at an international level. Since October 2022, it forms the innoFSPEC transfer laboratory together with the Chair of Knowledge and Technology Transfer with the task to initiate collaborations and transfer scientific findings and methods into practice.

Sebastian Zimmermann and Aaron Justin Koenig test the method of photon density wave spectroscopy within the "Applied Analytical Photonics" group, which can be used to monitor chemical, physical, and biological processes in undiluted, turbid liquids on an industrial scale and in real time. Glass fibers transmit laser light through the sample, whose properties change the light intensity. Conclusions can then be drawn about the quality and composition of the sample. With the experiment that is presented here, a neutralization reaction of an acid with a base in which silicon dioxide precipitates, the measurement technology is assessed and refined in the laboratory. This method is also used in the production of nanoparticles or in algae cultivation.

Photo: Thomas Roese

↗ Scan to read more about InnoFSPEC

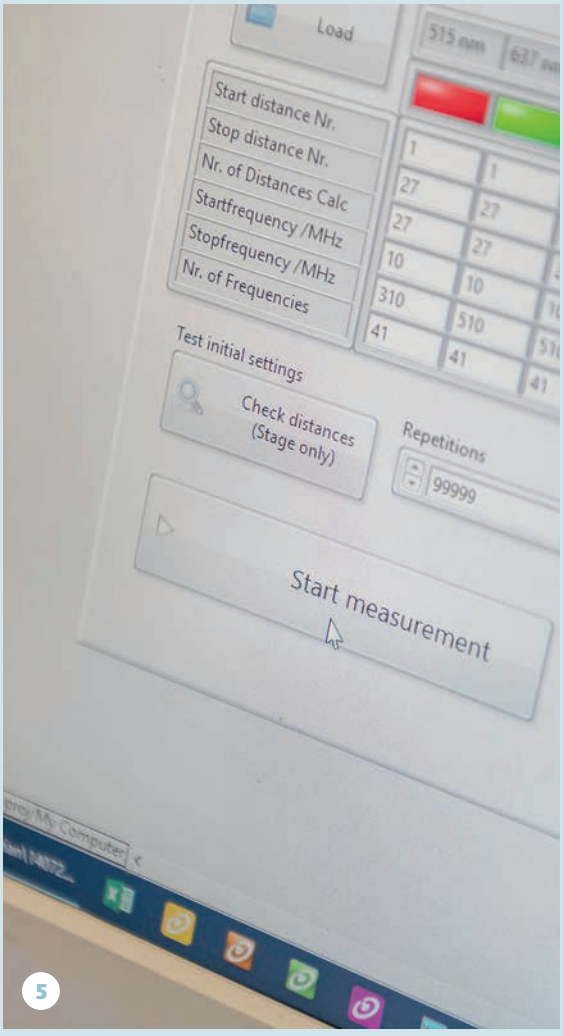
1 First, distilled water is heated to 80°C in a six-liter glass reactor. The required chemicals, sulfuric acid (H_2SO_4) and water glass (Na_2SiO_3), are measured and prepared.

2 Zimmermann connects the fiber optic cables of the measuring probe for photon density wave spectroscopy, which is in the reactor, to the spectrometer.

3 Koenig places the dosing hoses in the chemical containers with sulfuric acid or water glass and attaches the pH probe to monitor the neutralization reaction in the reactor.

Photos: Thomas Roese (3)

4



5

Photos: Thomas Roese (3)

THE PROJECT

The **NanoPAT's team** consists of 16 partners from eight countries and is part of an EU project funded by Horizon 2020. It is developing three novel real-time nano-characterization Process Analytical Technologies (PATs) for the investigation of nanoparticle syntheses focusing on the in-situ application of the techniques/methods and direct links with participating industrial partners.

Participants: IRIS Technology Solutions, University of Potsdam, Medical University of Graz, POLYMAT, Zurich University of Applied Sciences, PDW Analytics GmbH, ANALISIS-DSC, Covestro AG, Evonik Industries AG, FLUIDINOVA, S.A., Arkema France, Creative Nano, TEMAS Solutions GmbH, Bio- NanoNet Forschungsgesellschaft mbH, EXELISIS PC, BRAVE Analytics GmbH
Funding: European Union / HORIZON 2020
Duration: 06/2020–06/2024

6

4 The researchers take a test measurement with the probe. The immersed rods serve as laser sources in the visible and near infrared spectral range to generate photon density waves in the light-scattering solution.

5 Zimmermann configures the automatic synthesis program on the computer and starts it. The pH value is set at the start of the measurement with one milliliter of the water glass solution.

6 The hoses for introducing the sulfuric acid and the water glass solution into the reactor are pre-rinsed so that no residual water distorts the measurement; then they are hooked into the reactor.

7 While the chemicals are pumped into the reactor, Koenig takes a sample from the mixed solution every five minutes using a glass pipette. These samples are used for another method in the adjacent lab: dynamic light scattering to measure particle size distribution.

8 The solution gels and its color changes to white. The researchers determine the viscosity increase point, a measure for the viscosity of the solution, by reading the relative torque, which reaches its highest value at that point.

9 The synthesis is complete. The data from the measuring probe is analyzed and compared on the computer. Then the reactor with the solution is cooled down.

DR. STEFANIE MIKULLA

THE RESEARCHERS

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Aaron Justin Koenig works in the NanoPAT project and is doing his doctorate in physical chemistry.

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Photos: Thomas Roese (3)

Collaborative Research Centers

SFB 1287: LIMITS OF VARIABILITY IN LANGUAGE

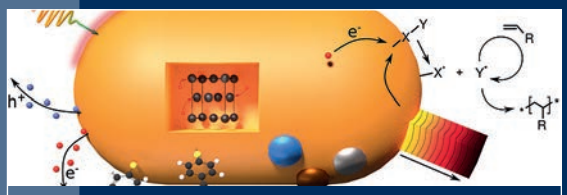
Why do languages often offer us so many different ways of expressing the same message, and how does our mental language system deal with this? How do such variations arise and disappear during language change? Is variability disruptive or even useful for language acquisition? The Collaborative Research Center 1287 investigates such questions considering cognitive, computational, and grammatical aspects.

Spokesperson: Prof. Dr. Doreen Georgi
(Intra-Faculty Unit Cognitive Sciences) – since 2017
↗ www.sfb1287.uni-potsdam.de

SFB 1644: PHENOTYPICAL PLASTICITY IN PLANTS

Phenotypical plasticity is the ability of organisms to develop different appearances depending on environmental conditions. Plants, for example, respond to their environment and can develop differently despite having the same genetic dispositions. The Collaborative Research Center 1644 pursues an interdisciplinary research program to understand what plasticity is based on at the molecular level, how it changes during evolution, and what limits the scope of plasticity.

Spokesperson: Prof. Dr. Michael Lenhard –
since 2024
↗ www.uni-potsdam.de/en/ppp



SFB 1636: ELEMENTARY PROCESSES OF LIGHT-DRIVEN REACTIONS AT NANOSCALE METALS

Light-driven chemistry at nanoscale metals is an emerging, interdisciplinary research field. It is based on experimental and theoretical foundations from nano-optics, condensed matter physics, as well as physical, organic, and inorganic chemistry. The vision is to amplify chemical reactions of nanoscale metals by coupling light, to make them more efficient and, in the long term, energetically enable them through sunlight.

Spokespersons: Prof. Dr. Matias Bargheer & Prof. Dr. Ilko Bald – since 2024
↗ www.uni-potsdam.de/en/sfb1636

SFB 1294: DATA ASSIMILATION

The Collaborative Research Center focuses on the integration of large data sets into complex computational models. Its goal is to better understand the underlying processes and to enable more accurate predictions. Data assimilation techniques are already being used very successfully in meteorology, hydrology, and the search for raw materials.

Spokesperson: Prof. Dr. Sebastian Reich
(Institute of Mathematics) – since 2021
↗ www.sfb1294.de

"SoMe4Dem"

How Social Media Can Damage or Strengthen Democracy

Fake news, manipulation, and opinion mongering – social media has made it easy to blur the lines between facts and opinions and influence public opinion on a massive scale. And this could be dangerous, and on a massive scale. That is why Stephan Lewandowsky has launched a project that has been investigating since January 2024 how social media influence democracy. "'Social media for democracy – understanding the causal mechanisms of digital citizenship' is a comprehensive and interdisciplinary project: The researchers come from the fields of philosophy, political science, computer science, mathematics, network science, and cognitive science, like myself." Lewandowsky is a visiting professor at the University of Potsdam and holds the Chair of Cognitive Psychology at the University of Bristol in England.

The project is based on two observations: On the one hand, democracy is on the decline in many countries around the world – including in the EU and the USA. "This is a serious problem," Lewandowsky says. "On the other hand, a look at the role of social media or online technologies in these problematic trends shows that they are – at the moment – not conducive to democracy. That is quite worrying." Many people in so-called Western countries are currently being polarized by the platforms, and trust in democratic institutions is declining. This development depends in part on what information is made available to people via social media. Control over this has partly been handed over to a few tech billionaires in Silicon Valley. "This is exactly where our project starts: We are trying to find ways to improve, to recommend ratings, assessments, and reviews. In other words: How can we design algorithms that present information to people in a newsfeed? And without compromising the quality of the information," Prof. Lewandowsky says.

This has not been the case so far. Current information systems are more concerned with keeping users on the platforms for as long as possible. "At the moment, the online ecosystem is what we call an attention economy. This means that when you are on Facebook, for example, advertisers effectively buy your attention." This is also ultimately a threat to democracy, as the algorithm and the way it works are not public and the decisions that users can make are made within the context set by the online platforms.

The approach of the research group: They want to establish so-called exogenous variables that can be used to determine the quality of information as independently of content and audience as possible. To do this, they analyze, for example, how websites are networked with each other, whereby, roughly speaking: the larger the network, the higher the quality of the information. Although Prof. Lewandowsky believes that social media can seriously damage democracy, he also sees positive trends: In so-called developing countries, social media can be used to spread knowledge about democracy, which will strengthen it.

LENA HIMMLER

THE PROJECT

SoMe4Dem: Social media for democracy – understanding the causal mechanisms of digital citizenship

Participants: Max Planck Society for the Advancement of Science e.V. (coordination), Leipzig University, Karlsruhe Institute of Technology, University of Potsdam, Università Ca' Foscari Venezia (Italy), Universiteit van Amsterdam (the Netherlands), Vrije Universiteit Brussel (Belgium), Fondation Nationale Des Sciences Politiques (France); Partner: University of Bristol (Great Britain)
Funding: European Union / Horizon
Duration: 03/2023–02/2026

↗ Scan to read more about the project

THE RESEARCHER

Prof. Stephan Lewandowsky, PhD, is Professor of Cognitive Psychology at the University of Bristol and Visiting Professor at the University of Potsdam.

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Photos: AdobeStock/Ilyuan (Hintergrund); privat

Enormous gains

Eight years ago, Miriam Vock initiated Germany's first qualification program for refugee teachers

How would I feel if I had to flee with my child from war and persecution to a foreign country, a country whose culture I don't know and whose language I don't speak? How would we find our way? Educational scientist Miriam Vock asked herself this question when more and more families from Syria came to Germany in 2015 seeking help. In addition to basic necessities such as a roof over their heads, clothing and food, the Potsdam professor believed it was essential for the children to quickly return to school. This, however, required suitable teaching staff. So she came up with the idea of qualifying Syrian teachers, who were undoubtedly among the refugees, for the German school system. Almost overnight, she developed the "Refugee Teachers Program". Initially, 15 spots were planned. But just a few hours after the university published the offer, the initiator was flooded with email inquiries. In just a few days, 700 applications were received. Looking through all of them, conducting interviews and checking suitability was neither planned in terms of time nor personnel. Then there was the huge media interest in this unique program. Never before, says the scientist, had a project cost her so much time and energy. But no other work has ever involved so much heart and soul ...

Since then, a lot has happened: Thanks to the funding from the Brandenburg Ministry of Science, the program has been expanded over the years and repeatedly relaunched, now also for refugees from Ukraine. A dedicated team is now running the program, which Miriam Vock believes should be made permanent, as the need for qualified teachers with different cultural and linguistic backgrounds will only increase in light of increasing migration. It is still a problem that teachers from abroad lack the second subject required in Germany in order to be fully recognized and permanently employed. The Refugee Teachers Program has now also set up subject-specific studies for this. Prof. Vock, who is now looking much more closely at how teachers are trained in other countries, would like to see a change in thinking. Almost nowhere else in the world is it common to insist on a second subject. In view of the teacher shortage in Germany, one can't really afford it here, either.

Prof. Vock has written and lectured extensively about her experiences. Other universities took up the Potsdam initiative and set up similar programs, for example in Cologne, Bochum, and Bielefeld. Even though she does not explicitly conduct research in this field, the Refugee Teachers Program has broadened her perspective and shown her what can be achieved in a very short span of time if all act in concert. The researcher recalls how the working group that was set up searched for solutions across all university structures quickly and pragmatically and how their work was characterized by a real sense of community and a great welcoming culture. An experience that touched her just as much as the personal encounters with the refugees, many of whom were severely traumatized, separated from family members, whose fate remained uncertain. Long journeys, overcrowded accommodation, no money to buy food – none of this stopped them from completing the intensive language and education theory courses. Miriam Vock, who usually sees herself more as an observer, analyzing and describing processes, took on the role of an actor and embraced the responsibility. In doing so, she left many other tasks unfinished. And yet she gained so much in the process.

ANTJE HORN-CONRAD

THE RESEARCHER

Prof. Dr. Miriam Vock has been Professor of Research on Teaching and Educational Interventions at the University of Potsdam since 2011.

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↗ Scan to read more about the Refugee Teachers Program

Photo: Valentin Marquardt

Dieter Neher

Professor for Soft Matter Physics and Optoelectronics

My daily life as a scientist currently focuses on our research into new types of semiconductors for solar cells. Some people may ask why this research is needed at all, given that solar cells made of silicon are available at an inexpensive price and in large quantities. However, their efficiency is physically limited to only around 29%. Silicon is also a poor absorber, which is why relatively thick layers of silicon, which also have to be produced at temperatures of more than 1,000 degrees Celsius in an energy-intensive process, are needed to capture all the light.

We are therefore researching materials that make it possible to produce very thin solar cells. I have been fascinated by so-called organic semiconductors for many years. These are colored hydrocarbons, similar to chlorophyll or carotene. By using new types of molecules (with unpronounceable names), it has been possible in recent years to significantly increase the efficiency of organic solar cells. At the same time, these solar cells can be produced much more easily and at lower temperatures, which significantly reduces their CO_2 footprint. We are trying to identify the processes that limit the efficiency of the cells and to develop ways that improve the photovoltaic properties. For this, we use a range of optical and optoelectronic methods in our laboratories. In one laboratory, we investigate how the components behave when they are illuminated by an artificial sun. This is a light source that has almost the same intensity and luminosity as sunlight on a cloudless summer's day. It is particularly fascinating to see how small variations in the chemical structure of the molecules cause major changes in the efficiency of the cells. To understand this in detail, we use a large laser in another laboratory that generates light pulses that are only 100 femtoseconds long. That is one ten-thousandth of a billionth of a second. We use this to investigate what happens in the semiconductors immediately after the absorption of a photon – a quantum of light: Does every absorbed photon generate free charges? Or are there losses that cause the photon's energy to be converted into heat or even lead to unwanted chemical reactions?

I really enjoy working with the junior research groups that I have been privileged to supervise. For example, the Sofja Kovalevskaja Junior Research Group of Safa Shoai developed techniques that have given us precise insights into the light-induced processes in organic solar cells. A second junior research group, led by Martin Stolterfoht, has been working on organic-inorganic perovskites, the new shooting stars of thin-film photovoltaics. A special property of these perovskites is the fact that radiation-induced effects in the crystal structure can heal themselves. I have been hosting Felix Lang's junior research group for a year. His Freigeist Junior Group has set itself the goal of developing new and better radiation detectors for medical X-ray diagnostics and flexible, ultra-light space photovoltaics based on these perovskites.

MATTHIAS ZIMMERMANN

THE RESEARCHER

Prof. Dr. Dieter Neher has been Professor for Soft Matter Physics and Optoelectronics at the University of Potsdam since 1998.

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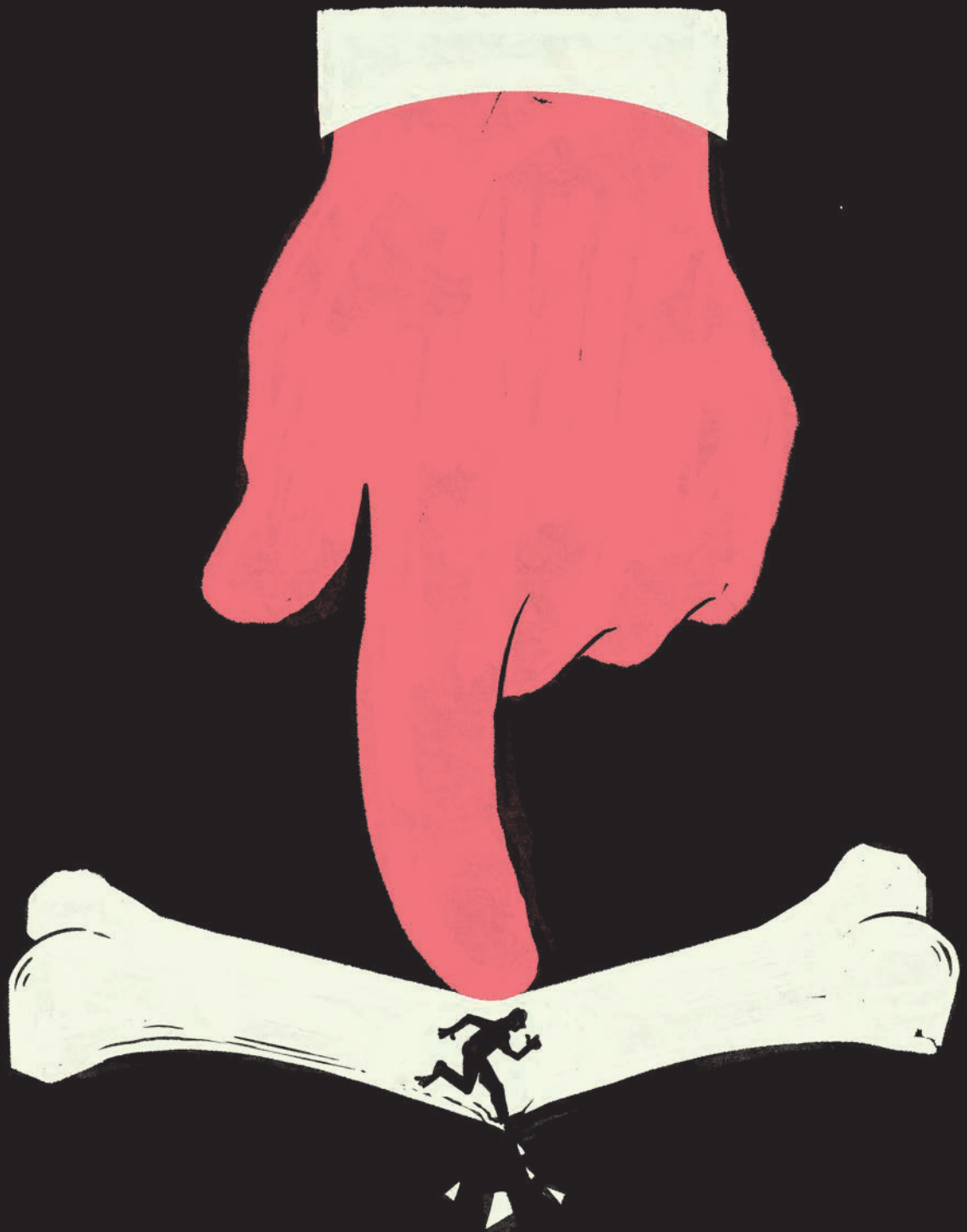
↗ Scan to view pictures and the whole text on the world of Prof. Neher

Photo: Kevin Ryl



RESISTANT IN A STRESS TEST

A Visit to the Laboratory of Prof. Pia-Maria Wippert

Illustration: Andreas Töpfer

A plain and white-painted room in the historic building no. 12 at Neues Palais, one table, three chairs. Nothing suggests that things are about to get stressful here. Or does it? There is a microphone in a stand in front of the table and a mirrored window at one end, through which everything that happens can be observed unnoticed from the next room. A video camera is standing on a tripod in one corner. "The setting is precisely standardized," explains Pia-Maria Wippert, Professor for Medical Sociology and Psychobiology. It is standardized for stress tests, which are regularly carried out here in the laboratory that she has set up especially for her research. One of the researcher's main interests is the development of stress and, most importantly, its effects. But for that, it first has to be generated and, of course, recorded and analyzed.

"The test is meant to trigger stress," Prof. Wippert explains. "Because this is what we want to measure." Among other things, this happens due to the hormone cortisol, which makes us perform better when it matters. In such situations, the body releases cortisol as well as noradrenaline and adrenaline. The brain then quickly receives glucose so that we can concentrate and work under pressure. Cortisol also increases blood pressure, accelerates the breathing rate, and makes the heart pump faster. At the same time, the stress hormone has a positive effect on the immune system and inhibits inflammatory processes. It can be detected in saliva, for example. This is why up to eight saliva samples are taken before, during, and after the test – depending on what the researchers are analyzing – to determine how the cortisol level develops. As it takes some time for the hormone to take effect in the body, the stress test actually begins before the interview: the test subjects prepare themselves alone, not knowing what to expect. At this point, the body already flips the switch. Ten minutes later, things are really getting started.

Three people enter the room, sit down on chairs behind the table, put documents in front of themselves. Then a young man comes in and is asked to stand in front of them at the microphone. He looks tense, trying to remain calm. The three facing him look stern, expressionless. That certainly doesn't help. He is asked to count backwards, quickly. He looks visibly stressed, the examiners unhappy. Even watching the scene is stressful. How might the "examinee" be feeling?

Stress has its good sides – in moderation

In fact, we experience stress reactions on different levels," Wippert says. "Emotionally, for example, it directly affects our mood, but also cognitively because we evaluate and review the situation immediately." The physiological reaction most frequently associated with stress is itself complex. After all, five hormonal axes are involved and become imbalanced – quite deliberately – through the release of cortisol & co. Because stress is not bad per se, the researcher points out. "We need a certain amount of tension in order to be able to adapt to different situations. If we are healthy and have sufficient resources, we are not 'stressed' but continue to develop." Our body actually has systems, its own feedback loops, with which it can stop the release of cortisol and restore balance. Stress becomes a problem when it catches us off guard, when our body is exposed to stress peaks too often or too strongly. Children and adolescents are particularly susceptible to this in certain phases of development, Prof. Wippert explains. "Especially in the early phases of our development, the brain undergoes major changes and interacts directly with the development of the hormonal axes. Strong stress reactions, such as those caused by early childhood trauma, can lead to dysfunctions, i.e. to a reprogramming of the functional level of the hormone axes, and thus have lifelong effects." But constant cortisol release is not good for adults either. "If there are no longer any resting periods in which the body can find its balance, or if a serious event leads to very strong stress reactions, there are overstress and wear-out effects." The fact that we are brought to our knees under constant stress is called "allostatic load" in research. This in turn can make us ill in various ways: Cardiovascu-

THE PROJECTS

The National Research Network for Medicine in Spine Exercise (MiSpEx), founded in 2011, is a network of 13 universities and clinics across Germany who joined forces to research back pain: in the interdisciplinary research project **"Ran Rücken – Aktiv gegen Rückenschmerz"** (2011–18), which was coordinated by the University of Potsdam (overall principal investigator Prof. Mayer). The goal was to develop, evaluate, and transfer function-related diagnostics, prevention, and treatment of back pain for elite sport and society. Prof. Dr. Pia-Maria Wippert and her team were responsible for the psychometric measurement setup and the psychometric methods for all three multicenter studies.

The project **"RENaBack"** developed and tested multimodal intervention modules in the aftercare of back pain patients. The goal was to develop a personalized therapy program tailored to the patient's own psychosocial risk profile, which patients can learn during the standard period of clinical rehabilitation and do independently as aftercare at home.

Standardized stress test in the lab

lar, autoimmune, and mental diseases and diabetes are now linked to stress, as is damage to bones, cell regeneration, the digestive tract, and DNA. Stress literally destroys us.

Stress makes us ill on a number of levels

Among other things, Prof. Wippert researches what stress "does" to our bones, and she has discovered something astonishing. "We were able to show that bone metabolism changes in people under high stress levels and that the density of bones can decrease." Their bones grow more slowly, break more quickly, and heal less well. In general, the ability of the body to regenerate suffers when there is a lot of stress. There were even different patterns of damage. "People with childhood trauma have a different pattern than people under constant stress," Prof. Wippert says.

A second important focus for the team is how stress affects other diseases, such as those that affect our muscles and skeleton. "Pain-related diseases are 'number 1' worldwide. And their numbers will increase," Prof. Wippert says. "Currently, around 540 million people worldwide suffer from non-specific lower back pain alone." In various projects such as MiSpEx and currently RENaBack, she and her team have researched how stress fuels the development of chronic pain. This actually happens in various ways, such as a tissue-related change in nerve fiber quality, a neurotransmitter imbalance, or an increasing neuronal activation in brain centers that are simultaneously involved in the processing of stress and pain stimuli.

In order to understand the exact mechanisms behind these processes, the researchers have now examined up to 5,000 people from the general population as well as patients in rehabilitation clinics. They analyzed blood, hair, and urine as well as microRNA for stress markers. In addition, they extensively interviewed those affected and often followed them for several years. "This enabled us to reduce the number of possible psychosocial factors that are important for the transition from an acute pain episode to a chronic course from 250 to eight," she says. "The social situation, vital exhaustion, critical events, and stress play an important role," especially factors that are significant for a person's sense of coherence. From this, the team developed diagnostics as an early warning system and an intervention that helps those affected to stabilize

↗ Scan to view the information film about the project "RENaBack"

Photo: Sandra Scholz

Performing under pressure

THE RESEARCHER

Prof. Dr. Pia-Maria Wippert is Professor for Medical Sociology and Psychobiology at the University of Potsdam.

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their permanently unbalanced system again – through moderate, individually adapted training. "Patients suffering from pain are often unable to exercise at all," the researcher says. "But it's exactly about getting them moving and training so that the system restarts." The diagnosis helps to find the right therapy modules for multimodal training based on the personal psychosocial risk profile. This contains modules that combine physical activation with cognitive training: Patients have to perform physical exercises and at the same time solve tasks that train their working memory. "MRI images have shown that this activates the frontal cortex and simultaneously reduces activity in the pain network," Wippert explains. The provoked new neuronal activation patterns erase traces of pain and enable people to train in the pain-free range. They literally forget about the pain and do not perceive it clearly. "They also become smarter because the metabolism in the brain changes and the processing speed increases." The signaling protein BDNF, which is important for nerve regeneration, also changes. However, it is important to adapt the training individually based on the analysis of the causes of pain that the team has developed.

The stress test has now been completed and the young man has been "released". Now the real work begins behind the mirrored glass where Prof. Wippert's actual laboratory is located. The team analyzes the saliva samples directly on site and combines the results with the evaluations of the video recordings. This is the only way to carry out the large-scale studies on site with the help of which the researcher wants to tackle stress.

MATTHIAS ZIMMERMANN

FURTHER READING

Current publications by Pia-Maria Wippert and her team on the topic:

Puerto Valenica, L., Arampatzis, D., Beck, H., Dreinhöfer, K., Drießlein, D., Mau, W., Zimmer, J-M., Schäfer, M., Steinfeldt, F. & Wippert, P.-M. (2021). RENaBack: Study Protocol for a Multicenter, Randomized Controlled Trial for low back pain patients in rehabilitation. Trials, 22:932. https://doi.org/10.1186/s13063-021-05823-3

Wiebking, C., Lin C.-I., Wippert, P.-M. (2022). Training intervention effects on cognitive performance and neuronal plasticity. Frontiers in Neurology, Neurorehabilitation. 5;13:773813. https://doi.org/10.3389/fneur.2022.773813

The samples of the stressed subjects are analyzed in the lab

Photos: Sandra Scholz (4)

Symmetric Tangling of Honeycomb Networks

Planar symmetry is a concept often encountered in geometry and design, where it plays a significant role in creating balanced and aesthetically pleasing shapes. It is also a fundamental idea in crystallography, where the study of planar symmetry helps characterize the repeating patterns observed in two-dimensional crystal lattices. A simple symmetric structure that we all know is the honeycomb pattern of packed hexagons built by bees. We call the network made by the vertices and edges of this pattern the honeycomb network.

We can ask the question: How does one tangle honeycomb networks together into a symmetric pattern? As an example, the structure shown in the image has 13 networks tangled together in a highly symmetric way. This is a question of interest to both mathematicians and synthetic chemists alike, used in the design and understanding of chemical frameworks, and as curious mathematical objects. In a recent paper, we studied this question using a constructive mathematical technique based on graph theory, low-dimensional topology and geometry. What we found was the enumeration of various highly symmetric entangled structures, with component numbers ranging from 1, 2, 3, 4, 6, 7, 9, 12, 13, and so on. We are even presenting an infinite series of structures with increasing numbers of networks tangled together, which in theory gives a method for the entanglement of infinitely many honeycomb networks together.

One can think of symmetry as a convenient route to building complex objects with relatively simple building blocks: make many of the small asymmetric patches, and then piece them together to form a large repeating pattern. This idea is employed by nature in structures such as virus shells, and in the lab in synthetic chemistry. Such a study here applies this idea of efficient design to the symmetry of how structures are tangled together, with possible ramifications in the design of microstructures materials.

PROF. DR. MYFANWY EVANS

FURTHER READING

Myfanwy E. Evans, Stephen T. Hyde, “Symmetric Tangling of Honeycomb Networks”, Symmetry 2022, 14(9), 1805; https://doi.org/10.3390/sym14091805

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