Positions

Our principles for good STEM education in a digital world



Deutsche Telekom Stiftung

<u>Adding</u> <u>real value</u>

Our world is digitizing at a breakneck pace. The education system is no exception. All experts agree: digital media can enrich teaching and learning at preschools, schools and universities. STEM subjects are the linchpin of Germany's future and present an opportunity to add real value by incorporating smartphones, tablets, microcontrollers and similar digital tools into the classroom. However, technology should always serve a higher educational goal, and not be an end in itself. This brochure contains ten positions that summarize Deutsche Telekom Stiftung's view of a good STEM education in our increasingly digital world. The principles are described in the following pages. I hope you'll find this information interesting and look forward to hearing your feedback.

Bonn, May 2017

Why alk

PROF. DR. WOLFGANG SCHUSTER CHAIRMAN OF THE EXECUTIVE BOARD DEUTSCHE TELEKOM STIFTUNG





Digitization offers plenty of opportunities

Bremen's Senator of Children and Education about the significance of STEM subjects in today's world and the huge potential found in new media.

STEM EDUCATION IS THE KEY TO THE DIGITAL WORLD

STEM training puts people in touch with our science- and technology-driven world and forms an indispensable part of a good general education. It can teach skills needed for tomorrow's digital businesses and workplaces and underpins research, development and innovation activities that demand a pioneering spirit, a passion for design and a thirst for knowledge.

WE WANT to demonstrate to the world that technological literacy education should be pursued proactively, not (merely) reactively out of an abundance of caution.

Claudia Bogedan has been Bremen's Senator of Children and Education since 2015. In 2016, she presided over the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (KMK).

Die What importance does STEM education have in our digital world?

STEM education is clearly fundamental to the digital world. It enables innovation, research and development and teaches young people how to discover new things and solve new problems. Without a basic understanding of mathematics and technology, young people can never be full-fledged members of our increasingly digitized society. Even the simple act of buying a train ticket requires a rudimentary understanding of how to use digital automation technology. Access to information – a cornerstone of democratic participation – has become inconceivable without the internet. If we want to prepare young people for this digital world, what role do STEM subjects play compared to other subjects?

We want to arouse children's curiosity and enthusiasm for STEM subjects early on and make math and science classes fun. That's why we support STEM projects and competitions at daycare centers and schools for children of all ages. These projects are investments in tomorrow's highly skilled STEM professionals that will enable us to compete in the global marketplace. In a digital world, though, education needs to be holistic and cover all subjects. Kids need to learn not only how algorithms and search engines work, but also how to critically evaluate sources and identify fake news, for example.

When you presided over the Standing Conference, you played a big role in developing the "Education in the Digital World" strategy. Why was this subject so important to you? And what do you believe are the main goals?

Digitization offers both risks and opportunities. In a digitized world, basic digital skills are needed to be a valued member of society, have good job prospects and participate in the local community. Algorithms are the fourth "R" of education after reading, writing and arithmetic. Plus, digital media is an education game-changer. It can spur the development and use of new teaching and learning methods and can foster childhood development and thus advance our goal of providing greater equality through education. That's why the Standing Conference's promise is unequivocal: all children who start school next year must acquire comprehensive digital skills. By the time they graduate, they should know how to develop and produce software, protect their personal data and recognize global production relationships and environmental impacts.

Bremen has been pursuing a state-wide coordinated strategy to digitize teaching since March 2014. It's the only German state to do so thus far. Its initiatives include providing a shared learning platform that all the schools use. Three years into this strategy, what conclusions can you draw?

The schools' experience with the learning platform has been very good. Teachers and students use it for various tasks: homework, class preparations, instructional films, substitution

schedules or communicating with each other. I believe that these platforms can reduce workloads tremendously, especially given our heterogeneous student body. Teachers' feedback has been very positive. It is equally clear, though, that digital media and learning platforms are no substitute for flesh-and-blood teachers.

The German federal and state governments developed strategies of their own in 2016 and plan to harmonize them in summer 2017. However, civic engagement has been rising in the past several years, especially among foundations. What role do you believe foundations should play, and what is their significance in this process?

Foundations can act as catalysts



The media education master plan in Bremen includes itslearning. Read more about this cloud-based learning management system on our website. www.bit.ly/itslearnin



Federal, state and local governments have to work closely together in supporting schools and other educational institutions. The Federal Minister of Education promised billions of euros in funding for states that have developed plans for curricula, teacher training and continuing education. Now she has to put her money where her mouth is.

Foundations can act as catalysts for change at individual schools. The studies that they conduct and the projects and events that they support can deepen stakeholders' digital expertise. All too often, teachers share the same hesitancy as parents in managing the risks and opportunities presented by digitization.



EEducation is either good or bad. Kids who receive a good education know how to navigate their environment successfully and adapt to the changing circumstances of the digital world. The classes may be digital or analog; both approaches work if done properly.

WE WANT to break new ground and show what good STEM education should look like in the digital world.



What characterizes a good education? Watch a video interview with Professor Wolfgang Schuster on YouTube.



"If used properly, digital media can enable good teaching. And good teaching generally always leads to a good education – both analog and digital."

PROFESSOR WOLFGANG SCHUSTER, CHAIRMAN OF THE EXECUTIVE BOARD DEUTSCHE TELEKOM STIFTUNG



At GestaltBar, a digital workshop, lower secondary school students program robots, develop basic computer games or learn about 3D printing. This improves their job prospects, too.







Alexander Hundenborn, a media educator, leads the class and helps students like seventh-grader Anthony program their robots. Later, these robots will have to navigate around obstacles as they follow a course laid out with tape.

Under the watchful eyes of seventh-grader Wiktor, the small Lego robot slowly rolls over the tiles. It suddenly halts in front of a cardboard box and then turns right and left again to elegantly circumnavigate the obstacle. The next turn is not quite as successful, though. The robot plows right into the box. Wiktor sighs, shakes his head and carries the mini-machine away.

Wiktor, who attends Karl-Simrock Secondary School in Bonn, taught the robot its routes on the computer and now has to tweak the algorithms. Wait, a seventh-grader is programming robots? It's nothing unusual here at GestaltBar, the digital workshop. GestaltBar workshops are available not only in Bonn but in Cologne and Berlin as well. One is planned for Hamburg, too.

This Deutsche Telekom Stiftung project teaches students how to use digital tools like computers and smartphones skillfully and creatively. While many of the students are more proficient users of technology than their teachers, they rarely understand the nuts and bolts that make the technology work.

"I do a lot at home with my smartphone, but I never knew anything about robots. Learning about them is a lot of fun," said Carlos, an eighth-grader. GestaltBar's mission includes preparing students for future careers. The better their digital skills, the easier it will be for them to find an apprenticeship or traineeship. After all, most modern jobs depend on computers and other devices. "GestaltBar specifically targets students in 'lower secondary schools'," said Dr. Ekkehard Winter, Executive Director of Deutsche Telekom Stiftung. "These students didn't use to have ready access to these kinds of training programs." As a side benefit, the students also work on their soft skills. "For example, they learn to be better organized and work in groups," said Dr. Winter.

These lessons are learned at multiple levels at the GestaltBar in Bonn. The workshop spans several grades. "The students come from different seventh- and eighth-grade classes and have to get their bearings in class as a team," said Erik Lindener-Schmitz, a GestaltBar teacher. Also, they have to travel a bit before the start of the course. GestaltBar takes place three kilometers from the school at "Haus der Jugend", a youth center.

"It's a whole new ballgame for them. First, the non-school environment is much more relaxed – no stress or pressure to perform," said Lindener-Schmitz. Deutsche Telekom Stiftung deliberately partners with institutions that work with adolescents. "Maybe some students will begin to use the youth center's programs in their spare time, too," said the



Eighth-grader Shekinah proudly presents her model robot.

foundation's Executive Director Dr. Winter. "After all, digital skills are needed for day-to-day life as well." The course is led by Alexander Hundenborn, a media educator at the Youth Media Culture Center in Cologne ("fjmk"). His students in Bonn have programmed robots, developed a basic computer game and built small cars with different drives. Other GestaltBar workshops provide insights into 3D printing. Hundenborn teaches the teens about the underlying technology as vividly as possible. "For example, when we talk about sensors, I like to compare them to the human body – eyes, skin, mouth and so on."

His approach pays off. Students usually rack up accomplishments much faster than in regular school classes. The pride in their faces is unmistakable when their robots execute commands flawlessly or their computer program works correctly. Take, for example, Sirin and Shekinah, two eighthgraders in Bonn, who are trying to teach their robot how to perform its next movements. No special programming language is needed. Instead, they assemble graphical blocks in stacks. Shekinah searches feverishly for a solution. All of a sudden, her partner smiles and points at the monitor. She has found the block, and the partners can continue programming.

Every week, seventh-grader Wiktor waits impatiently for Wednesday – the day when GestaltBar opens its doors again. For him, it's crystal clear: "I'd love to have a job where I work on computers or robots." But graduation is still some time away.

www.telekom-stiftung.de/gestaltbar

Technology and engineering - now more digital than analog - demand technical skill and an analytical mindset. They are disciplines where children, whether highly gifted or educationally disadvantaged, can discover their pioneering spirit and passion for design inside and outside a formal education setting (creative perspective).

WE WANT to show how to foster technology and engineering skills and entrench "computational thinking" at every stage of the education system as a key skill for the digital world.

4 "S" AND "M" HAVE TO SEIZE DIGITAL OPPORTUNITIES

Digital support for learning and teaching is still in its infancy, not only in science and mathematics but across all subjects (technical and subject-specific educational perspective).

WE WANT to enable experts and teachers to use digital media to improve learning and teaching, and help them integrate and effectively teach about modern research and applications – applied mathematics, simulation, modeling, sensors, big data, bioinformatics, et cetera.



<u>The mix</u> <u>matters</u>

Foundation Executive Director Dr. Winter about good classroom teaching in the digital world.

What do we want children to learn in school – pure facts or the ability to use facts to solve problems? This question has been hotly debated in Germany since the early 2000s, when the country was collectively shocked by its poor score in the Program for International Student Assessment (PISA) and consequently shifted its focus to competency-based learning. There are now two camps: The reformers support comprehension-based learning that draws on context and tries to incorporate real-life problems into the curriculum. The traditionalists, on the other hand, demand a return to conventional teaching methods and expect students to reproduce a predefined body of knowledge.

So far, so tricky. But which camp is right? I think they both are. Why should students still memorize mathematical formulas, English vocabulary or historical facts if they can pull out their smartphone and instantly access this information online at any time or place? Shouldn't schools teach students how to use information instead of the information itself? One point for the reformers. Obviously, though, the reality is a bit more complex.

Just think about navigation systems in cars. No more poring over street maps, always take the direct route to your destination – that's the promise of GPS technology. What people often forget: drivers still need to know the rules of the road



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Follow Ekkehard Winter on Twitter: **@ekkwinter**

and be able to tell the gas pedal from the brake pedal. Or, to cite a more school-related example: I can't use the Pythagorean theorem to solve an everyday math problem if I don't know the theorem itself. One point for the traditionalists.

In my opinion, schools should teach a mix of competencies and subject-matter knowledge. The specific proportions of this mix may vary from one discipline to the next. While one discipline may continue to emphasize the importance of accumulating factual knowledge, others may rely more on contextual comprehension. Overall, though, schools need to prepare our children more than before to solve real problems with available data – that's what is required in the world we currently live and work in. That includes teaching them how to distinguish reliable information from falsehoods, true knowledge from fake facts as they navigate the vast expanse of the internet. Without this skill, digitization's opportunities will remain nothing but an empty promise for them.

PROBLEM SOLVING BEATS ROTE MEMORIZATION

Digitization has put facts at our fingertips. Today, we have to focus on redefining the educational canon and teaching the competencies required to solve tasks and practical problems with easily accessible information.

WE WANT to achieve a breakthrough for competency-based teaching – which has already brought about a paradigm shift in education – on the basis of solid background knowledge.



Personalized learning is an effective response to the growing heterogeneity of the student body. It takes better account of an individual's needs, learning ability, approach and even misconceptions. Personalized learning can be implemented in an analog fashion, but digital media promises to support this endeavor in valuable ways.

WE WANT to demonstrate the potential of digital media for enabling personalized, cooperative learning and fully and systematically leverage it in the education system.

Better learning

"Bring your own device" (BYOD) means that students bring their own digital devices to class. Dietmar Kück, a teacher, knows the benefits of this approach.







7 TEACHERS AND STUDENTS NEED SKILLS FOR THE DIGITAL WORLD

All people, not least professionals and teachers, need more than basic user skills (application perspective). They also need a deep understanding of how ICT systems actually work (technological and economic perspective) and affect individuals, society and politics (societal and cultural perspective).

WE WANT to contribute to the consistent definition and implementation of these competencies at every stage in the education system.

Breaking the cycle

Is it possible for student-teachers to graduate from college without any exposure to digital media? That sounds like an untenable situation to Kerstin Mayrberger, a Hamburg-based media education expert. She explains what needs to change.

Professor Mayrberger, how much is digital media included in teacher training?

Right now, you can complete all your classes without ever being exposed to digital media. It's time to introduce digital media in all phases of teacher training and include digital media on final exams. I'm pinning my hopes on a paper that has been jointly drafted by the Standing Conference and other experts. Without this kind of formal lever, I don't think much is going to change.

What would have to change?

Right now, we have a vicious cycle of bad experiences and general skepticism: college students who don't have productive, educationally useful experiences with digital media become skeptical about its value. We need to break this vicious cycle at the university level.

How important are teachers' fears about losing control?

That's certainly another big reason for their opposition. Digital media inevitably erodes the amount of control that teachers have in the classroom. Instead, teachers end up ceding responsibility to students and acting as mentors. So not only do teachers have to know how to use digital media properly in the classroom, but they also have to gracefully handle the new forms of communication and class organization that digital media require. Learning venues and schedules look very different from traditional, predefined structures and can intrude into one's private life. That leads to a loss of control. But it also offers an opportunity to teach young people how to work independently and take responsibility for the outcome of their work.

What should modern teacher training look like?

At universities, we should build up media education competency. In other words, we have to systematically sensitize college students to the need to examine the educational aspects of teaching with and about media in the classroom. This includes exploring how their future students live and are socialized with digital media, the importance of media in education generally and in class organization. Of course, all this should be deeply anchored in educational theory. But the teachers have to do their part, too. They have to think outside the box, keep up with education research in this field and understand how the "real world" is becoming increasingly digital.

New momentum

Deutsche Telekom Stiftung provides assistance at various levels to advance the digitization of teacher training. For example, it supports six universities that are developing and testing methods for productively using digital technologies in elementary school classes. Through the FundaMINT scholarship program, the foundation teaches digital media skills and other competencies to future teachers. Also, it plans to establish another university network in 2018 that will develop scenarios for tomorrow's STEM teaching and learning and thus generate new momentum for teacher training and research into subject-specific teaching.



THE WORLD CHANGES, BUT VALUES STAY THE SAME

We must teach values that help future generations develop healthy personalities and social behaviors in the analog and digital worlds.

WE WANT teaching and learning for the digital world to cover mindful media use, awareness of how media use affects our community and careful consideration of the risks and opportunities that digital media presents.



You should not ...



Inspirational examples

Digital media paves the way for new things. It makes school more personalized and encourages sharing between students, teachers and university and industry partners. Four examples illustrate how this might work.

Landscapes instead of classrooms

All 448 students at the Osterholz-Scharmbeck High School in Lower Saxony have their own cubicles. Each cubicle forms part of a vast "learning landscape" where students are only allowed to whisper. Each grade has its own learning landscape. Teachers have special workspaces, too, and help students when asked to do so. The school's innovative learning system encourages students to learn independently while teachers act as mentors. Conventional teacher-led classes are restricted to "input rooms", which also host partner and group lessons. Lessons can also be taught in soundproof learning berths that dot the façade like bay windows. In early 2014, students and teachers relocated to the state-of-the-art learning center in the heart of the city's new educational campus, complete with a media center, cafeteria, gym and all-weather pool. "We've traded our chalkboards for Wifi throughout the building," said principal Dietmar Krause. Teachers use smart boards while students switch between laptops and pen and paper. If they need a break, students can unwind in a special "quiet room".



🛞 www.campus-ohz.de

Modern architecture: At the learning center in Osterholz-Scharmbeck High School, students can find inviting spaces for studying and relaxing in and outside their learning landscape.

Team spirit among teachers

Teamwork drives success. And not just at companies, either. More schools have discovered the benefits of working as a team. Teachers don't just work together within a single faculty, but collaborate across school and state boundaries. The pisa4u social learning platform, instituted by the OECD to support school improvement, brings together teachers from all over the world. Over 4,700 education practitioners from 172 countries have signed up. Teams of five teachers, each from a different country, work on solving concrete problems, such as finding better ways to support at-risk students.



School across all channels

Students at the European School in Bornheim make more than they consume. In the arts, that is: they film movies, record audio dramas and learn interactively. All thanks to classroom laptops and wall-to-wall Wifi architecture. Faculty members first saw how digital media could enrich the educational experience back in 2005. The comprehensive school had enrolled in "Interactive School", a Deutsche Telekom Stiftung pilot project. Teacher Henrik Holtbernd explained, "Digital media open up personal learning paths. Students can learn at their own pace across multiple channels – visual, auditory, interactive or conventional text-based." Older students act as media tutors and show younger kids how to use new media responsibly. Several media concepts have been incorporated into a media development plan that the European School is putting into action. The school is driving digital education in other regions, too, as part of the NetzSpannung. KT school development project for Rhine-Sieg County and in the Forum for Digital Education (see page 19).

🛞 www.europaschule-bornheim.de



Uplifting technology: at JIAs, students receive hands-on, basic technical education.

Nothing beats hands-on

The best way to get students excited about engineering and technology is to take them to where things are happening - companies, universities and laboratories. Unfortunately, schools rarely seize the opportunity to form permanent relationships with industry and university partners. It can be done, though, as shown by schools that have instituted their own Junior Engineers' Academy (JIA) with support from Deutsche Telekom Stiftung. The aim of JIA is to give young people a basic technical education, get them interested in technical and scientific careers and help them transition from school to work. Learning can take several different forms. Sometimes, students visit a partner company. Other times, they operate machinery under supervision, take apart engines or program apps. JIA is a two-year elective that is firmly integrated in the curriculum.

🛞 www.telekom-stiftung.de/jia



A NEW APPROACH IS NEEDED FOR EDUCATIONAL INSTITUTIONS

Changing requirements for teaching and learning in the digital world require new approaches to organizational and staff development (pedagogical and organizational perspective).

WE WANT to promote a holistic view of (STEM) education, from new designs for school architecture (special STEM rooms) to the involvement of extra-institutional partners to intra-institutional continuing education using peer learning, reverse coaching and team teaching – combined with a culture of sharing enabled by digital media.



The Forum's work is often influenced by teenagers' opinions, such as at a workshop held in Berlin last year.



(10) GOOD EDUCATION FOR THE DIGITAL WORLD IS BEST DONE TOGETHER

One key player alone cannot make a serious contribution to improving education in the digital world. It requires federal, state and local governments, working together in the spirit of cooperative federalism, and support from civil society groups such as industry and university partners.

WE WANT to launch or incubate scalable lighthouse projects while working with private, public and government partners to scale up best practices to achieve our common goals.

Stronger together

The Forum for Digital Education is a meeting place for key players in education, politics, academia, industry and society.

Prof. Dr. Wolfgang Schuster



MEMBERS OF THE INITIATIVE'S STEERING COMMITTEE

Together we are strong, together we are heard. That's why no fewer than five major foundations have joined forces in a single initiative. The Forum for Digital Education's key players are Deutsche Telekom Stiftung, Bertelsmann Stiftung, Robert Bosch Stiftung and Siemens Stiftung, with additional support from Stiftung Mercator. Our goal: to be collectively regarded as a go-to partner for politicians and to advance education in the digital world.

Put plainly, our goal is to pool knowledge and offer a platform for key players in society, education, politics, academia and industry. We are driven by one fundamental belief: digital media can help master educational challenges such as teaching heterogeneous groups. After all, we believe weaker students deserve a better education, too.

But what does successful education look like in a digital world? This is a regular topic of discussion among education experts at round tables, dialog forums or workshops. It breaks down into three questions: How can we use digital media to achieve the best possible education outcome for everyone? What competencies do we need for the digitized world, and how can we teach them? Finally, what do educational institutions require in order to harness the power of digitization for teaching and learning?

Our focus in these discussions is educational, not technological. As foundations, we are convinced that educators must find ways to capitalize on the opportunities of digitization. One project created to advance this goal is schulentwicklung. digital, a workshop set up by the Forum's initiators with 38 schools as participants. The schools have begun to respond to the challenges of learning in an increasingly digital world by changing the culture of teaching and learning. They share experiences at the workshop and jointly define critical areas of development that will make digital education at school successful.

These collaborative activities have paid dividends. The Forum for Digital Education has caught the attention of the German Federal Ministry of Education and Research, which now regularly shares information with the initiative to "jointly develop solutions and practical concepts." The Standing Conference is satisfied, too: "I am thrilled to see a broad platform emerging that will help us tackle education reform," said Udo Michallik, its Secretary General.

Other foundations that address education and digitization are invited to join the Forum. As the Forum moves forward on this issue, it remains committed to its guiding principle: "Education before technology."

🛞 www.forumbd.de



<u>About</u>

Deutsche Telekom Stiftung was established in 2003 to strengthen Germany's position as an education, research and technology leader. It is one of the country's main corporate foundations with an endowment of EUR 150 million. Deutsche Telekom Stiftung's mission is to support good education for the digital world, focusing on science, technology, engineering and mathematics (STEM). It focuses on four core areas: Education Drivers, Education Opportunities, Education Innovations and Education Dialog. To maximize the impact of the foundation's projects, Deutsche Telekom Stiftung brings highly regarded education and science experts on board its activities from the start. They provide guidance and advice during design and implementation.





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