Werner Liese is no ordinary teacher – and his students aren’t ordinary either. The day a friend invited him to sit in on a chemistry lesson he was teaching at the Carl-Strehl-Schule in Marburg, Germany, changed Werner’s life. He realised that with his hobby – fiddling with electronics – he could make a real difference here. Werner had just finished his training as a secondary-school biology and chemistry teacher and gained a PhD in inorganic chemistry at Marburg University, so he went straight to the school’s headmaster and asked for a job: he wanted to apply his skills to using and developing tools for blind and visually impaired students, to help them do experimental work in the science classroom.

Werner got the job, and over the past 29 years has been very successful as both a teacher and technical developer, and has brightened up numerous students’ lives. “It is so important that the students can do their own experiments. This not only helps them to understand the way scientists work – it is the only viable way to make even complex topics transparent for the students – otherwise they remain just theories. It makes all the difference.”

Swelling paper is a special kind of paper which swells up when combined with ink and heat, for 3D representations of diagrams, such as this set-up for the fused-salt electrolysis of sodium hydroxide.

Blind date in the science classroom

Biology and chemistry teacher Werner Liese talks to Marlene Rau about the challenges of performing science experiments with blind and visually impaired students.

A blind student uses a Braille terminal to check the text she has just typed on her laptop. A Braille terminal is actually more expensive than the laptop itself.
Today, the Carl-Strehl-Schule accommodates more technology than your average school: students take notes mostly on laptops; visually impaired students use digital enlargers to magnify the text they are reading; and blind students can scan in text, after which it is either read aloud to them by a computer or represented on a Braille terminal – an electromechanical device for displaying one line of Braille characters at a time by raising pins on a flat surface.

When Werner started his job, things were very difficult. There was not a lot of technological support for his students, let alone for the science classroom. Many experiments had to be explained and the students had no opportunity to experience them first-hand. Shortly after he joined the school, Werner started developing electronic tools for teaching science to the blind and visually impaired. A full-time electronics engineer was employed to help, and a dedicated workshop was fitted for the task. “Not one teaching-materials supplier worldwide offers ready-made materials adapted for blind students – the market is just too small,” Werner states sadly. “I was very lucky that, for a time, the school relieved me of the majority of my teaching duties so that I could dedicate my time to developing these tools. This, and several generous grants, made it all possible.” What special needs do his students have? “Of course it wouldn’t make sense to concentrate for weeks on end on the chemistry of coloured pigments in a classroom full of blind students. But basically, you can teach any science topic at our school, just as you can at any other. For grades 5 to 10,
we have adapted the curricula to our students’ needs, but from grade 11 onward, they need to prepare for the general school-leaving certificate (Abitur), which enables them to go to university. The exam questions are the same for all students in the federal state, so our students need to learn the same material as their peers. We actually collaborate with other secondary schools in Marburg to offer joint courses for sighted and visually impaired students in subjects for which there are very few students.

“The main task for the teacher is to translate visual impressions into impressions our students can perceive with their other senses – mostly acoustic or tactile. Similar tools are employed in all sciences, but chemistry requires the most complex adaptations. For our visually impaired students, we use cameras with special optics to transmit details of the experiments to computer screens. With this the students are able to zoom in sufficiently to easily follow experiments being demonstrated by the teacher or other students. In our media centre and electronics lab, we design instruments that convert light or colours into sound or synthetic speech: students weigh out chemicals with special precision tools, and we fit standard measuring instruments with large digital displays and voice output.

“I had to learn a lot about analogue and digital electronics as well as computer-aided design to be able to tackle more complex projects, such as a digital burette which for the first time enables blind people to perform precise titrations. We fitted a standard burette with an electronic interface that sends the data to an adapter we built, which has a voice output and a very large display. Coupling the burette to a data-recording programme allows the students to produce not only tables but also graphical representations of the data. These can then be made available in tactile form by printing them onto ‘swelling paper’, a special kind of paper that swells up when combined with ink and heat.

“Many of the tools we have produced in our workshop are not available anywhere else. However, two of the instruments that we developed are also commercially available: a talking digital multimeter, and an ‘optophone’ – an instrument to measure light intensity and electrical conductance and translate this into sounds at different pitch.”

Another project Werner is particularly proud of is the LiTeX programme\(^1\), which he has been working on over the past nine years; it is now the most comprehensive German-language writing tool for the blind and visually impaired. “It is a freely downloadable template for Microsoft Word\(^2\) which enables the simple integration of formulae, equations, structural formulae and Lewis notation for maths, physics and chemistry, and offers a number of important help functions for writing normal texts which weren’t available before. Even many sighted people find it useful.”
Werner is also active outside the school walls. When his former PhD supervisor founded the Chemikum teaching lab at Marburg University, Werner was called in to develop experiments and adaptations to enable blind and visually impaired people to use the lab. This experimental chemistry lab is open for anyone aged four and above – school classes, groups or individuals – to attend demonstrations or take part in hands-on experiments.

This project fulfils Werner’s ambitions for science education: “Anyone can enjoy science. But it is extremely important for teachers to be creative in their use of equipment. This is true not only at a school like ours, but in any classroom. Besides, he or she has to be enthusiastic and transmit this enthusiasm to the students.” Werner’s students demonstrate his success – one of his former students, a blind boy, has graduated in biology at Marburg University, while another visually impaired student has successfully completed a PhD in chemistry. Werner has achieved his goal: he has made science more accessible to everyone – including the blind.

**Web references**

w1 – Find out more about the Carl-Strehl-Schule on the school’s website (in German): www.blista.de/css
w2 – The LiTeX programme is freely available on Werner Liese’s website, which also contains more information about Werner and his work (in German): www.werner-liese.de
w3 – The Chemikum Marburg offers anyone aged four and above the possibility to do chemistry experiments (in German). See: www.chemikum-marburg.de
w4 – Learn more about the German Institute for the Blind (Deutsche Blindenstudienanstalt) here (in German): www.blista.de

**Resources**

To browse all teacher profiles in *Science in School*, see: www.scienceinschool.org/teachers

---

Dr Marlene Rau was born in Germany and grew up in Spain. After obtaining a PhD in developmental biology at the European Molecular Biology Laboratory in Heidelberg, Germany, she studied journalism and went into science communication. Since 2008, she has been one of the editors of *Science in School*.

Marlene’s father has been blind since he had an accident at the age of 20, and she has lived in Marburg for much of her life – going to school and university with blind people, meeting them on the street every day, going horse-riding with them, teaching them Latin, sharing a house with a blind friend and living opposite the Carl-Strehl-Schule for a couple of years. Blind people have always been an integral part of her life – and she finds that their lives are not so very different, really.