I Was a Student of Stephen Hawking's – Here's What He Taught Me

Like many students of my generation, Stephen Hawking had already had enormous influence on me long before we ever met. When I was hesitating about my A-level choices, it was his book A Brief History of Time that convinced me to continue with physical sciences. In 1994, Hawking and mathematical physicist Roger Penrose gave a series of inspiring lectures about cosmology in Cambridge. As a direct result, I chose courses on black holes and relativity for my fourth year of study at the University of Cambridge.

I first saw Hawking when I was an undergraduate. At that time he was living in an apartment building just behind my student house. He was already so famous that friends would come to my room just to watch him leaving and entering his apartment. But as an undergraduate I never tried to talk with him, feeling much too junior and intimidated.

After I finished my fourth year, I was invited in to talk to Hawking, who was already using a speech synthesizer, about options for my PhD. I was quite nervous when I first met him, but he jumped straight into physics and soon we were discussing black holes. I became a student at the time of the "Second String Theory Revolution" in theoretical physics. Hawking had not worked actively in string theory, but he was very keen to understand the new ideas.

Following that meeting, he sent me off to read all the papers that Edward Witten, a famous string theorist, had written that year. My task was to come back and summarise them for him – the student teaching the master. It's difficult to describe how hard this task actually was: Hawking expected me to jump

straight to the frontier of string theory as a starting graduate student. He also chose the title for my PhD thesis: "Problems in M-theory", which I worked on from 1995 to 1998.

I can only hope that my explanations of string theory were helpful. Hawking went back and forth on his views on M-theory, but eventually ended up thinking that it may be our best bet for a theory of everything.

No hand-holding

PhD students were enormously important to Hawking. In the early phase of his illness, his students helped take care of him. By the time I became his student he needed round-the-clock nursing. At this point, his students were no longer involved in his physical care, but remained essential to his research. Theoretical physics begins with ideas and concepts, but these then evolve into explicit detailed calculations. Hawking had a remarkable ability to do complex calculations in his head, but he still relied on collaborators to develop and complete his research projects.

Theoretical physicists typically give early PhD students "safe" research projects, and guide them through the calculations required. As the students develop, the projects become more ambitious and risky and students are expected to work independently. However, PhD students working with Hawking did not have the luxury of this gentle introduction – he needed us to work on his own high-risk, high-gain projects.

Hawking's communication via his speech synthesizer was necessarily concise and he simply could not provide detailed guidance about calculations, making it extremely challenging to work with him. But it was also stimulating, forcing students to be creative and independent. He did give praise when he thought it was due. He once sent me away with a very hard problem – finding exact rotating black hole solutions of Einstein's equations with a cosmological constant – and was

stunned when I came back a few days later with the solution. I can't even remember exactly what he said but I will never forget his enormous smile.

Hawking was a determined and stubborn person. On many occasions he got through serious medical issues with sheer determination. This same determination could make him very difficult to work. But it could also push research projects forward: Hawking would refuse to give up on seemingly unsolvable problems.

In fact, never giving up is the main thing Hawking has taught me – to keep attacking problems from different directions, to reach for the hardest problems and find a way to solve them. It's immensely important as a scientist, but also in other aspects of life.

Pithy one-liners

Hawking was devoted to his family. His eyes would light up when one of his children came to visit or when he proudly showed us pictures of his first grandchild. In many respects, Hawking treated his PhD students and collaborators as a second family. However busy he was, he always made time for us, often making dignitaries wait outside his office while he talked physics with a student. He would eat lunch with us several times per week, and funded a weekly lunch for the wider group to bring everyone together.

There were many occasions when physics discussions merged seamlessly into social activities: going to the pub, eating dinner at one of his favourite Cambridge restaurants, and so on. Hawking had a wonderful sense of humour. He turned his communication difficulties into an advantage, composing pithy one-liners. For instance when changing his mind about what happens to information in a black hole, he announced it in the pub by turning the volume up on his synthesizer, saying simply: "I'm coming out." He would discuss anything and

everything in a social setting: politics, movies, other branches of science, music.

As we worked in closely related fields, we saw each other regularly even after I finished my PhD. In 2017, I attended a conference in Cambridge celebrating his 75th birthday. The list of participants illustrates Hawking's influence on academia and beyond. Many of his former students and collaborators have gone on to become leaders in research in cosmology, gravitational waves, black holes and string theory. Others have had huge impact outside academia, such as Nathan Myhrvold at Microsoft.

There is currently pressure on academics to demonstrate the immediate impact of their research on society. It is perhaps worth reflecting that impact is not easily measurable on short time scales. Hawking's was truly blue-sky research – and yet it has fascinated millions, attracting many into scientific careers. His academic legacy is not just the remarkable science he produced, but the generations of minds he shaped.

There's no doubt Hawking's death is a huge loss to physics. But personally, what I will miss most is his humour and the general feeling of inspiration I got from being around him.

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