INTERNATIONAL HIGH SCHOOL TEACHER PROGRAMME AT CERN: REFLECTIONS ON MY EXPERIENCE

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SUMMARY: Read about a high school teacher's unforgettable two weeks at CERN, witnessing firsthand the power of international collaboration in scientific discovery. This reflection shares how the experience is inspiring new ways to motivate students and cultivate a lifelong love for learning and problem-solving.

CERN, Conseil Européen pour la Recherche Nucléaire, was created in 1952 [1] and its design is an example of how humanity can work together to solve complex problems. CERN's mission is multi-faceted and includes discovery, innovation, collaboration and education. They provide particle accelerator facilities so that physicists can perform world-class research in fundamental particle physics. Their aim is to be environmentally responsible and sustainable as they expand humanity's understanding of what the universe is made of and how it works. CERN ensures collaboration on purely scientific research and shares the results of experimental and theoretical work with the public. People from all around the world are united for the benefit of humanity as they push the boundaries of science and technology unconstrained by geographical borders; international collaboration is the driving force behind all research, innovation and discoveries. Lastly, CERN hopes to engage everyone in the values of scientific research and train the next generation of engineers, physicists and technicians [2].

In July of 2024, I attended the International High School Teacher (HST) Programme in Geneva, Switzerland at the Large Hadron Collider (LHC) at CERN, and became a student again for two weeks [3]. It was one of the most rewarding experiences of my life, both personally and professionally. I attended world class lectures, visited cutting edge facilities, participated in workshops and developed a network of international colleagues. I met some of the most talented engineers and physicists that this world has produced. It was humbling to witness the greatness that humanity can accomplish when we all work together! It is now my duty, as an alumna of HST 2024, to spread their message and ignite scientific wonder in my science and physics classes.

Figure 1. Amanda Craig and Daša Červeňová creating a cloud chamber at a Science Gateway workshop. Science Gateway is CERN's new education and outreach center.

Science in general has tried to answer fundamental questions throughout history, and the work at the LHC is no different. Physicists want to know where we come from, what we are made of and where we are going. By looking at the smallest, fundamental particles, we can look back in time to get information just a few moments after the Big Bang. What is special about this type of fundamental research, however, is that no one can anticipate the spin off benefits that can result. The knowledge gained at the LHC over the years has led to the invention of the world wide web [4], touch screens [5], and medical applications such as cutting-edge cancer treatment [6].

Our current understanding of the universe is incomplete [7]. We need more information about the Higgs boson so we can measure its properties. While we have found the particles predicted by the standard model, this does not offer a unified description of all the fundamental forces because it cannot describe gravity. Current observations have shown that visible matter only accounts for 5% of the mass-energy in the universe [8]. We still do not know what the remaining 95% of the universe is made of. The search is on to find dark matter and dark energy [9, 10]. Also, we do not know why we have not been able to find antimatter in our universe [11, 12]. This is exciting for students, teachers and physicists the world over.

At CERN, the best and brightest particle physicists and engineers tackle the impossible. Currently more than 17 000 people from over 100 nationalities work together to question the boundaries of human knowledge [13]. The information that results is free and available to everyone. In this technological age of greed and consumerism, CERN stands firm in its belief that knowledge should be shared and not used for personal gain. The takeaway messages that I want to bring to my students are ones of

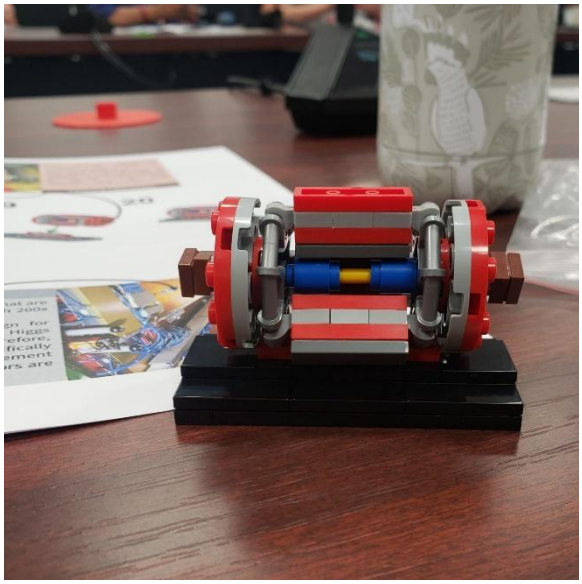

Figure 2. (left) Amanda Craig outside of the ATLAS control room. ATLAS is the largest detector ever constructed for a particle collider and is used as a general purpose particle physics experiment. (right) A ”mini-CMS” particle detector created using Lego.

creativity and ambition. The common thread amongst people working at the LHC is a mindset of lifelong learning. Impossible is only a mindset and with the right people working together, amazing solutions can be found for the most difficult problems. To overcome the monumental problems facing our world, one must not only have the knowledge but also be adaptable and creative in their approach.

My experience as a participant in HST 2024 has not only deepened my understanding of fundamental physics but has fundamentally reshaped my pedagogical approach. Inspired by CERN's collaborative spirit and relentless pursuit of knowledge, I am committed to evolving my teaching practices to better prepare students for the complexities of the 21st century. My key educational goals include:

1. **Fostering Scientific Literacy and Inquiry-Based Learning:** When completing my masters studies, I focused on the educational leaders’ perspectives of scientific literacy and much has changed since then. I plan to update my course notes to include relevant examples in particle physics to generate interest and introduce content beyond our provincial curriculum. I want to make science relevant and exciting for students using an inquiry-based approach and design lessons that challenge students to ask “How do we know?” rather than “What do we know?”[14]. Using real world data I can adapt questions and investigations, moving away from rote memorization towards genuine scientific exploration.
2. **Enhancing Critical Thinking and Problem-Solving Skills:** I hope to motivate students and activate their knowledge using a more active and hands-on approach by incorporating teaching

resources from both the Perimeter Institute (PI) and CERN. The challenges faced at CERN, such as the search for dark matter or the mysteries of antimatter, exemplify complex, open-ended problems. I want to use authentic learning experiences to equip students with skills vital for their future studies as well as the evolving world of work. Using inquiry-based, problem-based or project-based approaches students are encouraged to think critically, collaborate, and iterate solutions, echoing the iterative process of scientific research at the LHC.

3. **Integrating Artificial Intelligence:** Each day we try to create independent learners to solve our world's problems, we see greatness in students when they don't see it in themselves, and we help students find their way on their own learning journey. The trick is to not lower your standards, to expect greatness and always strive for better. This message rings out loud and clear at the LHC. Their work is highly data-driven and increasingly reliant on computational tools, including machine learning and AI. Recognizing the growing importance of digital literacy and AI fluency, I will introduce my students to how AI is used in particle physics and how students can use AI to help them on their own learning journey. I hope to foster an understanding of AI's capabilities, ethical considerations, and its role as a powerful tool for scientific discovery and problem solving.
4. **Incorporating Global Collaboration and Networking:** CERN stands as a beacon of international cooperation, a model that directly informs my commitment to fostering a global learning community. As a member of HST 2024, I now have a network of international teacher friends to work with in order to improve my own craft and this is one of the greatest gifts of all. I joined the Math Science Special Interest Council and wrote an article for their newsletter about my experiences during HST 2024. In October, I helped coordinate professional learning sessions in St. John's and Corner Brook delivered by the Perimeter Institute which helped connect more teachers to the PI Teachers' Network. I delivered a lunch and learn session at Gonzaga High School with their STEM club all about the work at the LHC. In the near future, I hope to hold in-person and virtual events for teachers and students to share my experiences. Using my new network of international teacher friends, I hope to explore virtual collaborative projects between my students and their peers abroad, providing authentic experiences of global teamwork. My ongoing and planned outreach initiatives are designed to extend this collaborative spirit to other educators, sharing resources and best practices for physics education across Canada.

Although physics is my passion, teaching extends beyond all our subject areas. Teaching is about fostering and nurturing the passions of others. My goal is to empower students to be curious, critical, adaptable, and collaborative learners, equipped with the skills and mindset to tackle the complex challenges of their future, much like the inspiring scientists and engineers at CERN. We all have much to give to this world and, therefore, much to share with each other. I have been so lucky to be surrounded by such supportive teachers, professors, colleagues, students, parents, family and friends on my own physics journey.

Many groups and organizations have worked together to send me to HST 2024, and to them all I owe a great deal of gratitude. Thank you to Dr. Stephanie Curnoe and the entire nominating committee of colleagues and former students for putting my name forward for the CAP Award for Excellence in Teaching High School/CEGEP Physics. It has been a humbling and rewarding experience to be recognized and has opened doors to other opportunities. Thank you to the Canadian Association of Physicists, the CAP Foundation, TRIUMF, Perimeter Institute, SNOLAB, and Canadian Light Source for sponsoring the teaching award and research experiences and for encouraging and promoting physics education in high school. Lastly, thank you to the Perimeter Institute and the Institute for Particle Physics who provided supplemental sponsorship for my trip to CERN.

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