

Teaching Web architecture and ethics to highly gifted high school students in a summer school

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In July 2012 we gave a course at the German National Summer School for high school students. It was about fundamental internet technologies and ethical aspects of the web's impact on modern society. The specific format of the Summer School curriculum, i.e. the course consisted of 50 hours over 14 days, required a detailed preparation of the course structure and flexibility in the course units. Besides our main objective, which was to give a deeper understanding of modern web technologies and applications, we also gathered some valuable experience for future teaching.

The main lesson learnt was that knowledge of the Internet protocol suite contributes to a better understanding of the decentralized and open aspects of the web. This leads to a better comprehension of the ethical aspects of the web like *net neutrality*, *copyright*, *relevance paradox*, *copyright* and others. We propose that any curriculum about Web Science should include a fair part of lectures on Web Architecture and the Internet protocol Stack.

The course was designed for 16 highly gifted high school students (11th and 12th grade). The level was supposed to be manageable for a second year undergraduate student. Since our students came from different class levels and schools we had to teach them some basic programming skills. Furthermore we focused on two main course objectives:

By the end of the course our students should...

1. ... understand the technical parts of current web architecture in particular the decentralized and open aspects.
2. ... should have gained the ability to form and defend a solid opinion on currently ongoing ethical discussions related to the Web. Also they should know about these issues and be able to identify them.

All students were asked to prepare a talk and read the book "Weaving the Web" by Sir Tim Berners-Lee before the summer school started.

Ten of the talks included the technical foundations starting with binary numbers going all the way to the application layer and all the necessary protocols. This included the theoretical study of *IP*, *TCP* and *HTTP* as well as routing algorithms (*BGP*) and *DNS*. These topics have been covered in the first week of the course.

In the second half we focused on the ethics of the web. This was done by an overview talk of 20 minutes on an ethical topic followed by a 2 hour group discussion. For example for the discussion on *net neutrality* we knew the following actors: *Large internet providers, big web companies, small web companies, politicians, consumers*. Students were randomly assigned to one of these actors. Within 10 minutes they had to prepare a list of arguments that would reflect the interests of their particular group as well as arguments they would expect from other groups. While discussing the issue on a round table they had to find a good solution respecting the technical nature of the web and the interests of their group.

Even though the level of the Summer School is very competitive participation is voluntary so there can't be an exam or something similar in the end. Also all work had to be completed during the 50 hours course time without any home work assignments. We had three evaluation methods to ensure the comprehension of the course content.

1. **Hacking Project:** To ensure a better understanding the students had to group themselves into teams. Each team had to implement a simple Web Server and a Web Client that were able to process HTTP 1.0 GET requests during course time. This was done using the Java Programming Language and the socket classes from the Java API. Being in groups of 2 or 3 students and being new to programming the hands on sessions did not contain any theoretical lessons about programming but rather interactivity which gave us a nice feedback whether or not students understood the content.
2. **Oral presentation:** After the middle of the course students had to prepare and give a presentation to be consumed by an interdisciplinary audience i.e the students from other courses of the summer school, which were all not covering any IT topics. We asked the students to create a theatre role-play of what happens if someone types *www.wikipedia.org* into a web browser and hits the enter key. All students placed routing tables on the seats for the audience, created TCP / IP packets (filled with candy that represented the time to live) and routed DNS requests as well as HTTP requests together with the TCP handshake around the audience in the class room demonstrating that the basic decentralized web architecture was understood by everyone in the course.
3. **Paper Writing:** During the last days of the course the students were expected to collectively prepare a 25 pages summary with scientific standards of what they had learned during the summer school. The process of creating this document was not only guided by us teachers but also turned into another a nice feedback loop to see if the goals of the course have been achieved.

Overall we experienced that putting such a high focus on Web Architecture and actually letting students implement protocols helped them a lot to develop their own view point on web ethics.