Involving students' 'toys' to make them learn - an example of learning digital signal processing using the low-cost platform ARDUINO

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In this presentation, a student-centred approach to select teaching tools will be presented and discussed. The overall concept is based on an analysis of the technological development and the way information is presented and processed in modern societies. The concept is aimed towards resolving the apparent mismatch between traditional presentation of information in teaching and recent trends facilitated by modern information technology. As an example, the ongoing inclusion of a recent low-cost electronics development platform (ARDUINO) into teaching of digital signal processing is presented.

While it seems reasonable to reduce the effort required by students to engage in the topic of some part of a curriculum, there exists an increasingly large gap between teaching methods and the way modern students learn in their everyday environment. The exponentially increasing presence and development of information technology not only changes the way information is being presented and consumed, but also how knowledge is constructed. Long newspaper articles are more and more replaced by shorter news items designed to be read on smart phones or tablets. More and more students get involved into programming of software (apps) or technological projects using low-cost prototyping platforms – also in their free time, replacing activities like reading. In teaching however, information is often presented in the same format and pace as decades ago. Hence, there seems to be a gap between the tools used for teaching and the ‘toys’ used for learning:

1. Theoretical knowledge is often exclusively taught on an abstract level under the preconception to be basic and hence without direct connection to applications

2. Concepts are often transmitted in longer units, requiring to be susceptible and trained for information intake over longer attention span

3. Applications might seem outdated and hence are perceived as much more abstract and irrelevant than intended

Since inherent motivation is the best motor for knowledge construction, such a gap seems counterproductive. Bridging this gap requires an extra effort from the student to adopt to the teachers way of information presentation and hence hinders the process of knowledge construction. Or it requires the teacher to anticipate the students’ way of information processing and consumption. Hence, the teacher needs to learn how to play with the students’ toys in order to evoke their inherent motivation to learn.

In this presentation, an example of application of this concept is presented to avoid such a gap. This requires the teacher to consider a number of points when selecting teaching tools – besides the formulation of learning objectives:

1. What is the level and amount of technology my students are exposed to on a day-to-day basis?
2. How much time do they spend using technology in their free time?
3. Which devices/systems do they use?

4. How big is the community using these devices/systems?
5. How are these devices/systems present in areas of interest (industry/science)?
6. How can these devices/systems be used to present the topic of the course?
7. How does the attention span required to operate these devices/systems match with the attention span required to process the course units?

This concept was first used in two bachelor projects, both focused on one technology (ARDUINO, ANDROID). Both projects had the goal to evaluate the platforms in terms of suitability for digital signal processing. The outcome of both projects was very positive. Already at a very early stage of the project, the students took ownership of the project. This lead to a performance which went far beyond the outline of the projects. In some areas, the students applied knowledge from other courses in order to solve single challenges which they defined themselves rather having them imposed by the supervisor. These are indications of inherent motivation and a strong learning process.

As a follow-up, the ARDUINO platform was considered for a funded project to adopt the system use in the teaching of digital signal processing, driven mainly by former students of the course. This traditionally very theoretical subject often suffers from a clear link to applications and examples – even though being present in modern information technology. Informal polls before the start of the ongoing course and during the semester indicates a clear tendency to include this platform into the teaching over another theoretical subject. Once the platform has been used in a teaching unit, feedback will be collected using a survey.

This approach has the potential to become part of a large collection of projects using similar technologies and platforms (Raspberry Pi, ARDUINO, ANDROID, etc.). Besides the purely educational value, inclusion of such elements will prepare the students for the culture of a rapid development and commercialization of innovative ideas accessible to a broad target audience like observed on the market for smartphone apps and the large number of crowd-funding initiatives.

Links to further information:

ARDUINO platform for development of electronic devices
http://playground.arduino.cc/Main/ManualsAndCurriculum
http://playground.arduino.cc/Learning/CourseWare
http://www.arduinoclassroom.com/
http://electronics.stackexchange.com/questions/67131/would-arduino-be-an-appropriate-platform-to-teach-high-school-students
http://www.arduinoteachers.com/

RASPBERRTY PI platform for development of computer-based systems
https://www.raspberrypi.org/

ANDROID platform for development of smartphone/tablet apps
https://developer.android.com/develop/index.html