DOT O&O. Developing Research and Design Skills in the Classroom (Dutch secondary education)

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Abstract
DOT O&O is a professional development programme for Dutch secondary school teachers on the subject of research and design skills. It is based on a designerly approach and is built around visits to design labs.

Author Keywords
secondary education; design; Fab Lab; STEM; CPD

Introduction
Research and design can be part of various subjects in secondary education. Accordingly there are many views on what research and design is, and research and design is applied differently in different disciplines. These disciplines themselves are evolving which generates fresh opportunities for research and design settings to develop. The professional development programme *DOT O&O*[1] takes stock of a number of such settings by visiting research and design labs at a variety of institutions. Participants' own questions form the backdrop to study the labs and transform findings from the visits into valuable insights for their own educational practice.

[1] Docent Ontwikkel Team Onderzoeks- en Ontwerpvaardigheden in de Klas (teacher development team on research and development skills in the classroom).

Research and Design Skills in the Classroom

Learning through hands-on activities is regaining popularity in education, often with reference to constructivist teaching and learning methods (constructionism [4]). More recently this has been linked to the global phenomenon of the "Maker Movement" (cf. [2]) and related to a more "designerly" approach in education (see e.g. [1]).

Such a design-driven understanding of research and design forms the basis of the DOT O&O programme. Following Pilloton [5] we aim at "a reinvention of vocational education for the 21st century" that takes over where the standard shop class left. By including a design-driven approach it adds a focus on the preproduction phase, it stresses the iterative nature of R&D activities, and it acknowledges and promotes the inherent creativity of research and design activities.

Since 2004 there exists the brand "Technasium" in Dutch secondary education. One of their flagship classes is called O&O[2]. The Technasium-branded O&O class focuses strongly on project-based learning. Projects ideally stem from real world problems and are defined in collaboration of the schools and businesses. The main goal of O&O is to prepare students for carreers in the technical sector [3]. The DOT O&O programme, however, is unrelated to the Technasium brand.

Design of the CPD Programme *DOT O&O*

The basic concept of the CPD Programme DOT O&O was to let secondary school teachers experience the practice of research and design, in order to enable them

- to make use of the design cycle and a practice "designerly" approach in class
- to apply research methods in class
- to design (and hold) classes that make use of modern machines and techniques
- to develop a corresponding educational environment in their school

The programme consisted of nine sessions spread over four months that included seven visits to different R&D labs (see below), within and outside educational institutions. The remaining two sessions were used for review and reflection. Seven teachers participated.

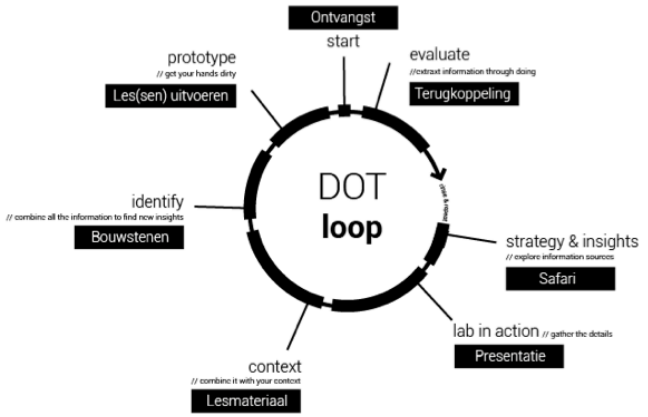
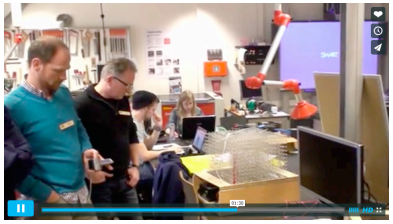
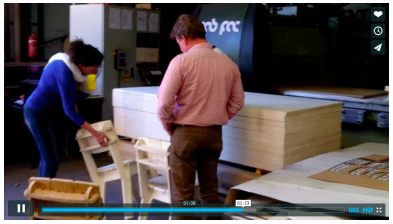


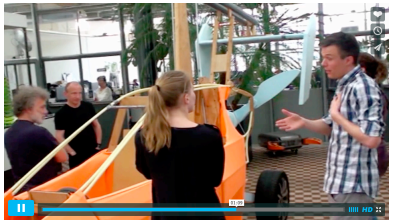
Figure 1. DOT loop.

Each of the seven lab visits followed a similar pattern (see figure 1), starting with a brief review of the work

[2] Onderzoek en Ontwerpen (research and designing)







Stills from the Lab Route clips. From top: Stadslab Rotterdam, Betafactory, Spark Design, Science Center Delft

so far (evaluate), followed by a presentation of the lab (strategy and insights) and a visit to its facilities (lab in action). Participants would then relate what they had seen to their own practice (context) and find new elements they could use themselves (identify). Between sessions they would apply new findings in their own practice (prototype).

In that sense the programme aimed not only at "showing" a designerly approach but in actual fact at practicing it. Sessions were also fully documented on video for further research.

Lab Route

Stadslab Rotterdam is a typical Fab Lab located within a higher education institution serving the student population and the city at large (individuals, business associations, businesses, local government).

Betafactory, Delft, facilitates educational projects based on real business topics in themed learning labs. Those include sustainable mobility, technology and health and building environment and energy.

RDM Makerspace, Rotterdam, facilitates access to 3D printing, laser cutting, CNC milling and heavy metal working mainly for schools, businesses and the city at large (individuals and local government).

Spark Design, Rotterdam, is a design agency working primarily in the business-to-business area (e.g. safety equipment) and occasionally creating exceptional concepts such as the PAL-V 'flying car'.

Science Center Delft is a science museum attached to Delft Technical University (TUD), making TUD achievements accessible to schools and families, e.g. the aerodynamic Senz umbrella, and solar racing cars.

STEM lab at the secondary school De Populier, Den Haag, has gained national reputation for its "FABklas" (fab class) where students can create their own high-tech projects in their free time.

Composites Lab at Inholland University, Delft, is dedicated to R&D projects in collaboration between companies and education in the field of composite materials.

Gains...

The programme generated a variety of gains for the participants, both collectively and individually. One participant lists these:

- sharing of own enthusiasm for making and designing with colleagues and students;
- knowledge on the possibilities, techniques and didactics of making and designing;
- overview of the variety of ways of using electronic circuits in class, catering for a diversity of levels of proficiency and interests which leads to learning, uniqueness and pride;
- learning from the experience of colleagues.

Collectively the participants developed a number of educational ideas for research and design lessons (e.g. develop a board game, disassemble broken machines an create new ones). They also studied and described various tools (such as Arduino, MaKey Makey,

Processing, InkScape, Tinkercad) and collected corresponding online resources.

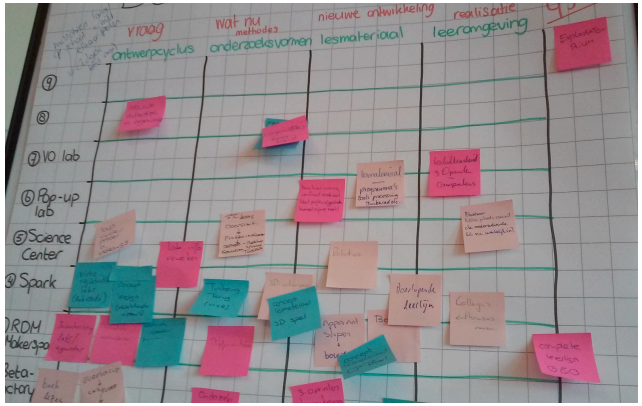


Figure 2. Evaluation DOT O&O.

...and Losses

Still participants found it hard to make the link between the labs and the educational situation in class and to transform the experience at the lab into an experience for the students in class. New material was difficult to incorporate into existing courses. Also, new didactic formats and insights were sometimes difficult to integrate.

The programme produced a large variety of ideas, yet participants were sometimes struggling to produce concrete results and to transform findings to practical educational content. A comprehensive framework for a class on research and designing did not emerge from the programme.

There were also practicalities that sometimes limited the application of results – limited number of computers in schools, restricted user rights on computers that prohibit installation of software, or machines regularly breaking down. And finally, the programme was awkwardly dense for the participating teachers who had also to juggle their regular teaching stint.

Acknowledgements

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