“CHEMARTSING” – an experimental, multidisciplinary, collaborative and future oriented pedagogy with wood based biomaterials

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Abstract: Aalto University’s CHEMARTS is a collaborative platform seeking to combine design and science. CHEMARTS has two main objectives: to inspire future designers and material scientists to work together solving the complicated problems related to production and use of materials, and to create novel sustainable biomaterial innovations for the future. In order to enable these objectives in higher education, an environment dominated by disciplinary pedagogical traditions, a set of completely new pedagogical approaches needs to be constructed. This paper presents a case study of CHEMARTS courses where new experimental pedagogical approaches have been tested.

Keywords: Multidisciplinary, Collaboration, Experimental, Biomaterials, Practice based

1. Introduction

Aalto University was created as the result of a merger of three universities in 2010. From the start there was an increasing demand for a new form of collaboration between art, design, business and technology. However, the fundamental issue related to interdisciplinary collaboration was how to create collaboration between different disciplines in practice? In December 2011 the Department of Design organised a half-day seminar with the title ‘Fashionable Technology’, where professors from design, fashion and forest products technology presented their work and shared their ideas on how to collaborate around the theme of future of sustainable biomaterials. The participants were highly inspired by each other’s experiences and knowledge. This resulted in a pilot project, which was organised in summer 2012 to see how ARTS students (School of Art, Design and Architecture) could collaborate with CHEM students (School of Chemical Engineering). Special funding allocated by CHEM

enabled recruitment of six students to explore ideas and experiment with materials freely throughout the summer. As an outcome to their collaboration they named their joint project as CHEMARTS. This pilot project was followed by two additional summer projects, now funded by the University.

In nature tiny seeds grow into plants, and in favourable conditions these plants flourish and create a durable ecosystem. That has been happening within the CHEMARTS community. Several externally funded research projects have been initiated. The summer activities have been running since 2012, new introductory course 'Design Meets Biomaterials' started in 2014, and CHEMARTS minor program open to all Aalto University students began in 2016. This paper will discuss the foundations for this collaboration by describing the summer courses from years 2012, 2015 and 2016. These cases represent multiple approaches in pedagogy. Through descriptive analyses of the pedagogical approaches, methods and experimental settings, a conclusion will be drawn describing the collaborative and experimental pedagogy used to educate future professionals with a multidisciplinary mind-set and skills.

Table 1. Introduction of CHEMARTS summer projects 2012-2014 and Summer Schools 2015-2016

Year	Students (ARTS/CHEM)	Tutoring	Given tasks	Document
2012 Project Design meets cellulose	6 (3/3)	Coordinator CHEM	Collaboration Cellulose experiments	Brochure by the team Interviews (2015)
2013 Project A peak into the future	6 (3/3)	Coordinator CHEM	Textiles	Brochure by the team Interviews (2015)
2014 Project Lost in the woods	6 (3/3)	Creative workshop by fashion designer, Coordinator CHEM	Bio Textiles	Brochure by the team Interviews (2015)
2015 Summer school Inspired by the Forest	8 (4/4)	Creative workshop by designer, Coordinator CHEM	Innovative products and processes	Brochure Learning diaries
2016 Summer school Art & Science	10 (7/3)	Mixed team of tutors, Coordinator CHEM	Biomaterials	Brochure Learning diaries

2. Experimental Pedagogy

2.1 Case background

The general idea of CHEMARTS is to explore wood based materials and their applications for innovative uses through student-centred and experimental approach. The teaching in CHEM is still based mainly on traditional methods commonly used in natural sciences; lecturing, reading, writing and working in laboratories. On the other hand, pedagogy in ARTS is strongly based on learning by doing, having focus on traditional art and design experimentations. The main objective of CHEMARTS is to inspire students from different disciplines to work together, to learn from each other, to experience hands-on material research and to find new ways to communicate design and science. The approach to teaching is future-oriented and experimental. It is based on practice based learning and collaborative learning (e.g.

progressive inquiry based learning). The inquiry based learning process can start before the problem is well clarified or framed (Hakkarainen et al. 1999) and through creative experimentations, collecting background information and team work the problem will be framed. The inquiry based and collaborative education process means learning through problem solving and working in a small cognitive community (Häkkinen & Arvaja 1999). The problem solving deepens from a dynamic and uncertain thinking into a clarified understanding of the problem until the new and collaborative knowledge is built.
Focus is given to the shared actions through which common understanding and new knowledge is constructed (Soini 2001). This pedagogical approach aims to deeper the problem solving and the opening of a complex phenomenon through shared expertise (different knowledge and disciplines) and collecting information collectively (Hakkarainen et al. 1999).

In CHEMARTS students work in multidisciplinary teams, and as teams define together the topics they want to focus on. No strict guidelines are given. The role of the supervisors is to provide some background information on wood-based materials, discuss the most relevant on-going research and describe the most applicable design methods. Students are encouraged to get out of their comfort zones: designers can become engineers and vice versa. As work safety is a top priority, the CHEMARTS student undergo safety training and are supervised by tutors throughout the course work. In the end of the course the collaborative process as a whole and the collaboration results are presented publicly through visual presentations and in an exhibition. Working methods and scheduling are analysed and further developed after each summer.

2.2. Case I 2012: Design Meets Cellulose

The first project was organised in summer 2012 with the title 'Design Meets Cellulose'. The participants were recruited as trainees and the team included three graduate design students, three graduate students from the forest products programme and a newly graduated tutor from material sciences. The team was given two tasks: 1) to familiarize with the latest cellulose related applications, and to explore the potential of cellulose in the future and 2) to figure out how design and wood-based material sciences could collaborate in practice. After kick-off lectures by professors and experts from different fields, the participants were free to organise their work with the support given by the tutor. The team spend three months familiarising with cellulose related materials and production processes as well as with each other's working methods. This pilot project set the foundation for the multidisciplinary collaboration and established the practice based working methods. The student team made a proposal on how the teaching collaboration should be organized and what kind of courses could be initiated in the future. They also created concepts of 'World of Cellulose' and 'Luxury Cellulose Finland', which were afterwards used as an inspiration for a significant strategic research opening 'Design Driven Value Chains in the World of Cellulose'.

Figure 1. Case I: Students' comment in the project brochure: 'It turned out to be very different from our initial expectations; many preconceptions about designers vs. engineers were erased early on in the project. The engineers have learnt new techniques to problem solving, working methods as well as visualization whereas the designers have learnt more analytical and technical approaches and gotten material knowledge.'

2.3 Case II 2015: Inspired by the Forest

In 2015 the first Summer School was organized. It was kicked-off by a four day workshop in the Finnish forest. The pedagogical idea was to let students learn about the main source of Finnish biomaterials by experiencing it by themselves, and by meeting people who are still working with traditional materials like pine bark flour ('pettu' in Finnish). Focus was on hands-on experimenting and prototyping first with wood in the forest, and later on in the laboratories with cellulose based materials. The concepts developed by the student included an eatable dish, wood-based water filtration, nanocellulose containing lampshades and personal hygiene products made from wood extractives. The outcome was presented publicly in several occasions. The mainly positive student feedback was gathered via learning diaries. Students from both ARTS and CHEM felt that they had succeeded in their projects, and learned from each other. One student would have preferred to have a more real-life project with a company, but that kind of approach was not included in the course.

Figure 2. Case II: To enhance the creativity from the beginning, the workshop was led by an internationally acknowledged designer. He took the team into the forest and gave the first task - to build a chair out of the materials found in the nature.

2.4 Case III 2016: Artistic & Scientific Explorations

The 2016 summer school turned out to be even more experimental. Firstly, all registered applicants (16) were accepted. Secondly, for the first time an external project assignment, an artistic installation for Helsinki Design Week, was included in the course content. Thirdly, the primary activity for the course was not defined - students could focus their work on anything related to biomaterials. The summer became very experimental, and from a tutors' point of view also very challenging. As there was no entrance selection, some participants were lacking the required enthusiasm and motivation. Several students quit and only ten students went through the whole course as planned. The course content was not as consistent and clear as it had been during the previous years, which left some students to pick up seemingly random ideas and to work mostly alone. Sadly the art installation project failed as it was not clearly connected to other activities and also lacked relevant support. Nevertheless the most committed, motivated and self-driven students worked hard throughout the summer with excellent results.

Figure 3. *Case III: Enhancing learning methods: learning through experiences.*

3. Discussion

We have witnessed that that the most important outcome of CHEMARTS courses is the overall learning experience. Collaborative learning is formed on cognitive, emotional and motivational aspects and their dynamic interactions and the outcome can be deeply shared meanings and new knowledge (Häkkinen & Arvaja 1999), and in our case also unique prototypes, which include and express collaborative knowledge. Deep and meaningful learning happens more often in complex and multilayered social situations than in individual learning situations (Lindfors 2009, 19). We can interpret that in these presented cases the experimental and creative approach has been the primary focus and through these multidisciplinary activities and actions new knowledge has been gained. According to student feedback, the CHEMARTs courses have opened up new perspectives and familiarized students with new working methods.

> *'The course was really interesting and a new learning experience for me. It was great to understand that there are other ways to learn than mathematic exercises and report writing.'*

> *'CHEMARTS summer school gave much needed direction to my studies and maybe even pushed me towards certain path in my future career.'*

During the CHEMARTS courses, students get familiar with different kinds of approaches and working methods. They are confronted with uncertainty, as they have to define their own goals and design their working processes by themselves. Material research takes time, and prototyping with experimental materials is demanding. There will certainly be failures and those failures have to be accepted. A creative mind-set, a persistent way of working and respectful collaboration are the keys for a successful CHEMARTS project. In the future it would be interesting to enhance even more systematically the development of collaborative knowledge creation through constructive design research (Koskinen et al. 2011).

It has to be noted that this kind of experimental pedagogy requires a lot from the supervisors and tutors. The balance between freedom and guidance is a delicate thing. Regarding the course development in the future we have made three conclusions based on supervisors' experiences of all five summers (2012-2016):

1. Student's personal interests and overall motivation have excessive impact on the outcome
2. Clear context will help and speed-up students orientation
3. Creativity and team building need support in very early stage of the course.

A successful multidisciplinary collaboration requires an open mind, curiosity, high motivation and respect for other's working methods and disciplinary knowledge. New kind of collaboration needs time and open dialogue to develop. There are many cultural challenges like the disciplinary language and working methods, which need to be addressed in order to be able to construct new knowledge and innovations for the future. The role of continuous dialogue and communication is crucial for continued success in the coming years. As one summer school student Tino Koponen concluded in his learning diary from 2016: '*It is all about chemartsing'*.

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