CHAPTER II

Reflections on internationalization of education

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RÉSUMÉ
The field of energy requires a global perspective. The amount of fossil fuel is limited and it needs to be shared among all people on earth. The concept being used by the author includes international exchange of master thesis students, meaning that student are formally enrolled in a master thesis course at his/her home university, but goes for the majority of thesis time (3-4 months out of a 5 months' time) to a overseas university to collaborate with local students and professors. All paper work is kept rather simple since formally the student is enrolled at the home university. The academic quality of the thesis report gets as good or almost as good as a student that stay in the home environment.
Mots clés : Internationalization; Master thesis projects, Bidirectional collaboration, Education, Students

Abstract
The field of energy requires a global perspective. The amount of fossil fuel is limited and it needs to be shared among all people on earth. The concept being used by the author includes international exchange of master thesis students, meaning that student are formally enrolled in a master thesis course at his/her home university, but goes for the majority of thesis time (3-4 months out of a 5 months' time) to a overseas university to collaborate with local students and professors. All paper work is kept rather simple since formally the student is enrolled at the home university. The academic quality of the thesis report gets as good or almost as good as a student that stay in the home environment.
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1. INTRODUCTION

The field of energy requires a global perspective. The amount of fossil fuel is limited and it needs to be shared among all people on earth. The world is becoming increasingly international and I believe that it is an important part of the engineering education at LU (Lund University) to prepare our graduating engineers for a

globalized working environment. To be able to work with internationalization in my teaching activities I am on regular basis applying for relevant funding. I am currently PI for an Erasmus+ project enabling 10 master thesis student to go to UESTC, Chengdu, China, for the experimental part of their master thesis, in a timeframe of 2019-2022. My first project enabling for student exchange was a STINT (The Swedish Foundation for International Cooperation in Research and Higher Education) project, in 2015-2016, where one Chinese master student the possibility to spend 20 weeks at LU, to perform a part of his master education, and one Swedish student to spend 13 weeks at UESTC in Chengdu, China, to perform the experimental part of his master thesis. From an individual point of view, the graduate students participating in the exchange are gaining not only scientific training, but also cultural experience needed in a more-and-more internationalized world, which was confirmed by the student evaluation. Besides the students participating in the exchange, also the local students that works/studies with their international guests benefits from the incoming students, in terms of for example, language skills, cultural experience and understanding of the field. It is important to point out that I expect the participating master level students to be well prepared for both an academic career, to continue as PhD students, as well as for an industrial career, which was also confirmed by the student evaluation. The cultural differences between the student life in Lund and Chengdu are big and not every student are interested to spend one semester in an environment that differs too much from their "home" environment. Consequently, during the selection of students, I am making sure that the students are familiar with the environment they are expected to visit as well as that each exchange student has a reasonable level of English.

My internationalization activities agree well with LU's strategic plan: Students who are studying at LU will have ability to participate in international efforts to create sustainable global development. To accomplish this, LU provides both students and staff the opportunity to spend time abroad. LU aims to put more focus on integrating international mobility for education. LU will give its students global awareness and international engagement. As of Mai 2022 I totally sent four master thesis students to perform the experimental part of their master thesis at UESTC, the first one wrote an OK thesis, but to improve the quality further, students 2-4 took our project based course (project-energy technology) to prepare themselves with additional theoretical knowledge before the master thesis. As a consequence, the results from students 2-4 was presented in journal articles, and students 2-3 also got price for best master thesis at LU faculty of Engineering - LTH.

> This thesis was awarded the LTH Jubilee Scholarship, i.e., price for best master thesis, for the year 2016, with the following motivation: The thesis concerns the development of a technology that has a great potential to become an important part in the future energy

> supply. Tara and Ida did the work with great independence in Chengdu, China, and their report is exemplary in its structure and language. The report also contains an interesting and very good introduction to the field of fuel cells. The experiments carried out are well planned, well executed and rigorously analyzed. Their work requires good knowledge in many of the areas that are introduced during the first three years in the Environmental Engineering education. It is clear that the work helps to drive the forefront of research in this important area forward, which is proven by the publication in an international scientific journal. Overall, their thesis satisfies very well the statutes of the LTHs jubilee scholarship.

As a teacher, it is inspiring with a more diversified group of students, which increases the teacher's motivation. I strongly agree with John Biggs (in Biggs, Teaching for Quality Learning at University) that "blame the student view of teaching", when the student group becomes more mixed (international) can be avoided with modified and reflected (for the international student group) preparations for the teaching activities.

I have also initiated an Erasmus teacher exchange agreement with Abant İzzet Baysal University in Turkey, enabling me as well as Professor Ali Naci Celik (at Abant İzzet Baysal University) for one week of yearly visits at each other's universities focusing on teaching activities and experiences. My first visit at Abant İzzet Baysal University took place in May 2015. It is of big importance for me to experience universities in the developing world to get a better understanding of my incoming master and PhD students previous education structure and quality, i.e., improving the supervision of my current and future PhD and master students on an individual basis.

2. EXAMPLES OF THESIS PROJECTS CARRIED OUT OVERSEAS

Adam Karlsson went to Kathmandu University (KU) in 2021/2022 to work on post harvest losses is a major concern for farmers in the Himalayan regions of Nepal and Bhutan. The lack of modern preservation methods, like refrigeration and controlled atmosphere, results in most farmers relying on open air sun drying to preserve their product. This method is outdated with many drawbacks. One suggested solution has been to introduce solar dryers to increase drying performance and increase food security. In Adam's study a novel solar dryer design was presented, which would increase the drying performance further. The design includes a heat exchanger that preheats the incoming air. Tests were carried out on a prototype that was constructed at KU. The results showed that the incorporation of a simple heat exchanger can increase the drying temperature in a solar dryer by 10 °C. Issues regarding the door

construction and the forced convection was highlighted during the tests. The design needs to be further developed before a final product can be presented.

Marion Karlsson Faudot went to KU in 2021/2022 to study food security around the globe. Efficient food preservation techniques must be developed, which is especially true for Nepal, where low agricultural productivity due to poor technical knowledge, lack of irrigation and fertilisers as well as unstable weather patterns affect the welfare of the farming community. Her master thesis investigates how the internal air flow of a solar drying chamber can be manipulated to increase the heat transfer while maintaining an even drying process. Results show that placing an inlet on top of the drying chamber, combined with two internal fans gives the highest drying rate amongst performed experiments. If an even drying process is favoured, an inlet at the bottom of the chamber with one internal fan can be used. An increase in internal air flow ensures better heat transfer inside the drying chamber, reducing the drying time. Future research should include possibilities of further improving the heat transfer and uniformity of the drying process by varying the net flow out of the drying chamber and by tuning the individual internal fans' air flow.

Mathilda Ohrelius went to UESTC in Chengdu China in 2019 to study the possibility of a completely green solution for energy distribution and conversión, e.g., fuel cells. A fuel cell converts chemical energy into electrical energy through a series of chemical and electrochemical reactions. Hydrogen has been the dominating fuel for fuel cells but a large obstacle for commercialization is the distribution infrastructure that needs to be planted. This problem has opened the way for another chemical energy carrier with a widely developed infrastructure. Ammonia (NH_3) is one of the most produced chemical substances globally, mainly used for fertilizers. It's easier to store and transport than hydrogen but the big challenge is the industrial ammonia synthesis, a heavily energy consuming process. Her master's thesis focus on the production of an active and selective catalyst for the electrochemical ammonia synthesis. A study was performed to investigate previous reported results of catalyst designs for the nitrogen reduction reaction (NRR). Noble metals have been proved to be stable and active catalysts but to decrease the cost of the material, transition metals offers a great alternative. To reach the performance as for the traditional Haber-Bosch process the catalyst need to be optimized. One approach to this is a nanoscale design of the catalyst to improve the availability of the active sites and the mass transfer. The perovskite $LaCrO_3$ is a ceramic material with great properties for heterogenous catalysis. The perovskite material is thermally stable with a great flexibility in tailoring the structure down to atom level. To find the perfect NRR electrocatalyst experimental and theoretical work needs to be furthered improved. One important aspect of this work was to get detailed material characterizations to investigate structure, particle size, surface properties, and electrical conductivity of the catalysts. From this, a relation between the catalytic activity and solid-state properties can be drawn and further material design strategies can be conducted. A

detailed characterization of the as-produced LaCrO3 crystals was therefore also conducted in the experimental part of this thesis, together with the electrochemical ammonia synthesis testing.

Fransson and Larsson went to UESTC in 2016 to work on fuel cell development. A fuel cell converts chemical energy into electrical energy through a series of chemical and electrochemical reactions. A solid oxide fuel cell (SOFC) is unique since it only contains solid materials and the cell has a fuel flexibility. Since the anode is the oxidising part of the SOFC, the anode material will greatly affect the overall cell performance and therefore the chosen material needs to hold various properties to ensure the efficiency of the fuel cell. A high porosity is required to facilitate fuel and gas transport through the anode and to maintain the porosity, the material needs to be chemically and thermally stable during the lifetime of the cell. The anode needs to provide enough active sites for the oxidising reaction to occur, good ion and electron conductivity is crucial as well as a high catalytic activity. These properties need to be combined with a cost efficient material and a simple production. Their master's thesis focused on a simple method for anode fabrication, by producing Ni-8YSZ nanofibres through electrospinning, a technique where fibres are formed by applying a high voltage over a syringe with anode solution and a collector plate. The nanofibres are evaluated by changing the electrospinning parameters and ratio between the materials. A closer distance between the needle of the syringe and the collector as well as a higher applied voltage increases the diameter of the fibres, whereas the nickel content seems to have no effect on the fibre structure. The XRD shows that the size of the crystals increases with higher sintering temperatures, which will generate vacancies in the fibre structure, enhancing the catalyst and improving the catalytic activity of the anode. The structure of the fibres produced with different polymers exhibit dissimilar appearance and an increased concentration results in an enlargement in diameter due to a higher viscosity of the solution. Due to its flexibility, the electrospinning method is suited for production of SOFC anodes. The fibres can easily be designed to fit specific needs by adjusting parameters, and a wide range of materials and setups can be used. However, the performance and the structure of the fibres need to be further investigated before a production method for SOFC anodes using electrospinning can be economically beneficial

Jonas Lindros went to UESTC in Chengdu China in 2015 work on the development of alternative methods for producing electricity with low CO2 emissions. SOFCs have the potential of producing clean energy in stationary power generation with high efficiency. The chellenge is that to be more competitive the fabrication cost needs to be lowered, which can be done by for instance using less expensive raw materials. Todays prime anode material is a nickel/ yttria-stabilized zirconia cermet (Ni/YSZ). When manufacturing the anode material, the Ni is bound in nickel oxide (NiO) and the standard weight ratio used today is 50/50 for NiO/YSZ. The purpose of the project in his thesis was to examine the possibility to decrease the Ni content in the

anode material, while maintaining good electrochemical performance. To do this, four different anode materials with varying compositions of Ni/YSZ was prepared. Since Ni is one of the more expensive compounds in the anode, less use means lower fabrication cost. However, it is difficult to decrease the Ni-content and still have good cell performance. The foundation for good cell performance is to provide lots of triple phase boundaries, which are the sites where the electrochemical reactions of the anode occurs. The Ni works as the electron conductor in the anode and with interrupted Ni-chains the cell works poorly. The structural integrity of the anode is also affected by the Ni-content due to the difference in thermal expansion coefficient between Ni and YSZ. It was concluded that another fabrication method might be more suitable, since the oxygen release during the reduction of the anode gives a great volume loss for the fibres and hence the structures might break. A more suitable fabrication method could be to prepare fibres with only 10% NiO and then add the rest by coating the fibres.

3. FINAL REFLECTIONS

The concept being used by the author includes international exchange of master thesis students, meaning that student are formally enrolled in a master thesis course at his/her home university, but goes for the majority of thesis time (3-4 months out of a 5 months' time) to a overseas university to collaborate with local students and professors. All paper work is kept rather simple since formally the student is enrolled at the home university. The academic quality of the thesis report gets as good or almost as good as a student that stay in the home environment.

It is hard to see new Nobel price being awarded to alone researchers. For impact, e.g., to solve our societal challenges, we need to collaborate, locally, nationally and globally. Students can indeed be included in research and research collaboration We have very good experiences for students exchanges when they are connected to on-going research project. A student exchange could also be a pre-study for research project funding application or similar

To stay as a top-university we need to collaborate. Future collaborations should be bilateral on equal grounds, i.e., not one side (historically certain European countries) telling the collaborators how things should be done. Knowledge need to flow in two directions, then we have a potential for significant impact

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