TEACHING SABBATICAL/ FINAL REPORT

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Preparation and Planning

The first step in planning my teaching sabbatical months at University of Tokyo was the first STINT meeting in Stockholm where we had interesting discutions about the university life in Japan and Tokyo with Anders Göthenberg (STINT) and Anette Wickström who visited the same university the previous year. Before travelling to japan, for the planning visit I had e-mail contacts, mainly with Prof. Jonathan Woodward and Prof. Yuichiro Watanabe from the College of Arts and Sciences and the administrator Akiko Takao. Akiko Takao helped me with practical details, both for the planning week and the sabatical stay, like the procedure of getting residence visa, renting the apartment, getting the health insurance and the library card, travell tips from the airport to campus. Both times I travelled with Finnaair, from Stockholm to Tokyo. In the beginning of March 2023, I visited the University of Tokyo, for one week to prepare the teaching sabbatical visit. I met Prof. Jonathan Woodward, Prof. Yuichiro Watanabe, Prof. Maeda Akira et al. They asked me to present the mathematics courses from a less theoretical perspective, to insist on applications and usefullnes of mathematics and not so much on proofs or theoretical matters. This was a real challenge for me since most of my life I worked with theoretical, basic courses. We talked about the organization of their university, they presented to me the Komaba campus and the infrastructure of the university. We discussed about the possible courses that I was about to teach. I accepted three of their proposals and rejected one. In the remaing time I started to prepare my mathematics courses.

Tasks and Responsibilities

The University of Tokyo has ten faculties. The **College of Arts and Sciences on Komaba Campus**, where I had my position, is one of them. A key feature of the undergraduate education at Tokyo University is that the first two years (referred to as the Junior Division) are devoted to the acquisition of fundamental skills necessary for further studies. The courses are common for all students at University of Tokyo, independent of specialization and are taught by this faculty. The two-year Junior Division provides a comprehensive liberal arts education. Aiming to cultivate cross-border knowledge within students, the Senior Division of the College of Arts and Sciences provides education that focuses on humanities, sciences, and interdisciplinary areas integrating arts and sciences.

In addition to being the school in charge of the Junior Division education for all the first- and second-year undergraduate students of the entire University, the College of Arts and Sciences provides a unique specialized education in its Senior Division. Focusing on interdisciplinarity, internationalization and innovativeness, the College of Arts and Sciences has aspired to foster cross-border knowledge within students. In other words, students are encouraged to have interests in many fields, actively involve themselves in culturally and linguistically different environments, and take the

initiative to explore new areas of learning. The **College of Arts and Sciences on Komaba Campus** contains a Department of Life Sciences with Graduate School of Arts and Sciences and a department with an entirely English degree program, called **PEAK (Programs in English at Komaba)**. Students from all over the world enter the program as first-year students through an admissions process resembling that of western countries. They are enrolled in the International General Education Program during their two years in the Junior Division, after which they choose to go on to either the **International Program on Japan in East Asia** or **the International Program on Environmental Sciences** for their Senior Division course. Students who entered the University through the traditional examination method may also advance to a Senior Division PEAK program as long as they meet certain requirements. The courses in the **International Program on Japan in East Asia** are divided into the following main areas: *Interdisciplinary Cultural Studies Approach*, *Area Studies Approach* and *Social Sciences Approach*. **The International Program on Environmental Sciences** main areas are *Environmental Principle*, *Management and Policy*, *Measurement and Evaluation*, *Material Systems and Dynamics*, *Energy and Resources*, *Health and Security/Urban Planning Technology*.

The PEAK faculty has also graduate programs at master and PhD levels in Environmental Sciences, where the students can deepen their knowledge and do research, in the areas mentioned above.

Because the College of Arts and Sciences features a large number of academic staff members who carry out research in a variety of fields, many of the classes are provided under ideal low student-to-teacher ratios. This enable application and experiment of many teaching methods as *flipped classroom* or *jigsaw* method. These methods of active learning are seen not only a way to enhance students' understanding of the subject matter and encourage active participation but also a tool for fostering teamwork, communication skills, and a sense of responsibility within a group.

The goal of this department is to cultivate talented individuals who can communicate effectively in the international community and come up with flexible ideas that go beyond the boundaries of academic disciplines. The science-related courses offer unique educational programs not limited to one specific discipline. Students can learn technical knowledge and insight that extends across more than one area. They can then use what they learned as a foundation for endeavoring into more advanced disciplines. The interdisciplinary courses intend to foster talented people who can handle new challenges from complex viewpoints. These people will be able to use appropriate methodologies and flexible ways of thinking that are not strictly limited to either humanities or sciences. The defining characteristics of the Senior Division of the College of Arts and Sciences lie in the variety of programs and learning methods the College offers to encourage students to go beyond disciplinary borders.

On the other hand, the **Department of Mathematics** is one of the departments of the **Faculty of Science**, another faculty of the ten of the university. Their students are enrolled in the first two years at College of Arts and Sciences and starting with the senior division at the Department of Mathematics. The graduate program, leading to a Master Degree is two years (minimum one) and the PhD program varies from two to three years. All courses are here given in Japanese but

some of their staff teach beside Mathematic courses at this department also courses at the College of Arts and Sciences, on all levels and also at the Program in English.

I hade the entire teaching responsability for three elective courses (with several codes), from administration and teaching to examination, for the PEAK students, in the second year of junior division, senior division or master level. Two of these courses extended during the whole autumn semester, called A (2 p) and one of them only in the second halv of the autumn semester called A2 (1p). The course on the junior level was *Applied mathematics* (13 lectures) and it was designed to demonstrate how mathematical concepts that students have learned in the pure mathematics classes are used and applied in advanced studies in the natural and social sciences. Understanding applications of mathematics in the sciences alllows students to deepen their knowledge and helps them to realize the importance of mathematics, in their advanced studies in the following years. The second course (13 lectures), on senior and master level was *Operations research: Mathematical optimization.* Operation research is based on the applications of optimization techniques to maximize or minimize a given objective function by controlling decision variables under the set of constraints. It plays an essential role in economics for its descriptions of economic decision making and valuation. The last module was called *Special lecture series on Environmental Science* (7 lectures), (1p), in the A2 term. The grading for all courses was based on attendance and participation to the lessons and homework assignments. I had full responsibility and freedom for building the syllabus, although I got some ideas about the courses with the same codes that were taught the previous year.

Activities during the Teaching Sabbatical

The main activity during the teaching sabbatical months was the teaching of the three courses: **Natural Sciences Seminar** (2p), for the junior divison of PEAK students, **Operation research** (2p), for senior division or graduate students and **Special Lecture Series on Environmental Sciences** (1p) for the senior division of PEAK-students. The two first named courses consisted of 13 lectures of 90 minutes and extended over the whole autumn term (A1 and A2) and the third, of 7 lectures of 90 minutes extended only over the second part of the autumn term, A2. The method of teaching was a combination of conventional lectures and interactive work. The lectures were delivered in English. In what follows I present the content of the course *Applied Mathematics*: 1. Dimensional Analyis and Scaling, 2. Perturbation methods, 3. Stability and bifurcation: one-dimensional ODEs. Population models, 4. Stability of linear systems of ODE-s, 5. Non-linear autonomous systems of ODE-s, 6. One dimensional discrete models, 7. Systems of discrete models, 8. Calculus of variations: Euler-Lagrange equation, 9. Isoperimetric problems, 10. Classification of linear PDE's and solution methods for simple PDEs, 11. Fourier series, 12. The one dimensional linear wave equation, 13. The one dimensional heat equation. The syllabus for the *Operation research course* was: 1. Optimality conditions for unconstrained optimization, 2. Sufficient conditions and Newton's method, 3. Modified Newton's methods, 4. Steepest descent and Quasi- Newton's methods, 5. Least square problems, 6. Applications, 7. Constrained optimization. Simplex method, 8. Optimality conditions for constrained optimization, 9. Linear equality

and inequality constraints, Lagrange multipliers and KKT-conditions, 10. Nonlinear equality and inequality constraints, KKT-conditions, 11. Log-barriers methods. Duality, 12. Variational calculus-Euler -Lagrange equation, 13. Isoperimetric problems. The third course *Special Lecture Series on Environmental Sciences* consisted of the following topics: Continuous Ecological Models, Continuous Ecological Delayed Models, Discrete Ecological Models-single species, Ecological models-two species: prey -predator type or competitive species.

Before each class I shared teaching-material on-line before. Moreover, in the last part of each lecture the students were working at some exercises. All courses were optional in the PEAK-program. I had the freedom to build the syllabus and to choose the teaching method. The teaching was done completely by myself.

Beside my own teaching, I visited some classes at the course Chemistry for the Environmental Sciences, taught by Professor Jonathan Woodward and his assistent, master student Ujjwala Thakar. The teaching was done in the system of so called "flipped classroom". Before meeting in the classroom the students had to watch, a lecture presented by Jonathan Woodward himself on You-toube. In the classroom the students were divided, in groups of 4-5, sitting at round tables. Each group got a worksheet that they had to hand-in at the end of the lesson. These hands-in assignements together with the students' own video-presentations and quize exercises counted 40 % at the final exam. In this way the students were trully involved in active learning. Both the teachers and students were very satisfied with the system.

I also followed all classes of the course Mathematical Modelling and Simulation, taught by Professor Ralph Willox from the Department of Mathematics and Graduate School of Mathematics, taken by PEAK-students from senior division or master students GPEAK. He had a classical teaching approach with lectures and hands-in. He shared some OH with computer visualizations of some results, but the main ideea was exactly to learn where the computers must be used very carefully, cannot be used or what to do if the results were not as expected. The classes were on a very high level and the course requiered a solid mathematical background.

Moreover, I attendend the Global Faculty Development program, **FD lunch sessions Let's talk teaching**, namely *Idea generation: Campus Internationalization-Systems Approach*, *Fostering interdisciplinary Education* and *Student Assesment* and **Time to talk session** as *Reframing Collaboration in Language Education and Beyond*. The role of these meetings is to offer an environment in which faculty can openly share their practices, ideas and challenges related to higher education. They serve the purpose of forming the basis of a community of teachers who think critically and reflectively about their teaching practices and who can share their ideas with their colleagues.

I attended the 90% presentation of the PEAK-students final graduation works in Sustainable Sciences and acted as an external examiner.

During this period I have continued my research with my PhD student from Ethiopia (financed by ISP, Uppsala) and with Professor Javier Sorina (University Complutense of Madrid). We had some on-line meetings and changed some mails.

I also contacted Professor Yoshihiro Sawano (Chuo University, Tokyo) whom I met twice at University of Tokyo. We started already a research collaboration, together with my collegue, Assoc. Prof Martin Lind (Karlstad University), in the field of Sobolev spaces. We will definitively stay in touch and continue our research collaboration.

I attended also the graduation of the students of the PEAK and GPEAK programs.

Important lessons

I taught all three courses at the University of Tokyo for the first time. Although a big part of the subject matter of these courses was known for me, a lot was also new. By having to prepare the syllabus and my lectures and I definitively gained a lot of **subject matter** expertise which I can use at my university, in the near future. Since the subject matter presented has a lot of applications in other sciences I had to refresh my knowledge from other subjects (e.g. physics, biology or evironmental sciences) and take a newer look at the importance of interdisciplinarity.

The lectures I attended gave me the opportunity to constructive critic and reflexions regarding the subject matter taught, the organization of the lectures and the difficulties that the students might have. I will definitively introduce jigsaw or flipped classroom teaching already in my next course since, these methods are very suitable for active learning. These reflections are also based on the discutions that I had with Professor Jonathan Woodward about his experience of this type of teaching and examination.

I became more open and flexible to different teaching methods and new pedagogies and definitively better to adapt to the preknowlege of different students and to different situations.

To understand students' needs you have to listen and communicate actively and constantly. I realized that this is very easily done if the size of the classroom is small. The reduced size of a classroom is a big advantage also from the perspective of creating a positive and inclusive learning environment. I appreciated very much the design of the final exam of the course Chemistry for the Environmental Sciences which seem to be very effective, with possibility to provide constructive feedback from the teachers as well as from the students in the classroom and to the videos that they have to analyse. Moreover, I realized the importance of being proactive and collaborative and having the ability to adapt to a new enviroment and to make quickly necessary changes, without to much byrocracy.

One important lesson is that the teacher should be opened and flexible in trying new pedagogies and teaching methods and to embrace new technology in education. Moreover to be able to quickly adjust to new enviroment is also desirable.

The ''jigsaw learning method" is not only a way to enhance students' understanding of the subject matter but also a tool for fostering teamwork, communication skills, and a sense of responsibility within a group.

Comparison between the host and the home institutions (in Sweden)

The PEAK department is known in University of Tokyo of having small classes, of about 30 students. This creates flexibility in the use of teaching methods and examination as well as active contact with the students. At Karlstad University, some courses, especially, the first years courses, have many students, sometimes about 200. For this reason any implementation of a different pedagogy than the standard ones, with campus lectures and seminars, needs a lot of work and coordination. At our university many courses are divided in lectures and seminars, opened for questions, but some students don't always take the opportunity for asking questions during the lessons and many don't attend all classes, since they are not mandatory. In Tokyo, at least some courses are given by using a "jigsaw learning method", as described above. The students watch the lecture on Youtoube before coming to the classroom

. In the classroom they work on given tasks that they hand-in to the teachers after the lessons. The teachers help them with the tasks and answer also to questions.

In Karlstad, at least for big courses, the exams consist only on written examination and not on the assignements or quizzes like it is usually done in Tokyo, partly due to the small number of students in the classroom.

The students from University of Tokyo have more places for elective courses in their programs than at our university. Since University of Tokyo is a world leading university, with tough entrance exams the students are very motivated and well-prepared in sciences and mathematics.

Both in Karlstad and Tokyo two current and challenging topics are namely *interdisciplinarity* and *building bridges between research and teaching*. In Tokyo, they worked at PEAK (Sustainable sciences) and the Department of Mathematics long time to implement and evaluate them. In Karlstad, we stress very much on these topics mainly in the students' final works but except some collaboration with industry companies, the evaluation was not made on a regular basis.

The basic courses in mathematics, in the first two junior years at PEAK, as well as in the first year in Karlstad have similar Curricula. We offer them as basic courses for engineering and civil engineering programs as well as for mathematics BSc program. In our university, the courses for future teachers have a more theoretical approach with emphases on proofs. The difference is that at University of Tokyo, in the Junior Division, they run compulsory courses known as Foundation Courses, which aim to ground students with the critical perception that will form the basis for any subsequent specialist field of study. Through classes in foreign languages, information sciences and physical education, both arts and science students will have the opportunity to develop their ability to understand and learn from other cultures and refine their sense of judgement and ability to take action, all of which are increasingly needed in a globalizing society. The science students are given the chance to obtain a broad foundation across the mathematical, material and biological sciences. One of the major aims of a liberal arts education is to gain an understanding of both the width and depth of academia from a macroscopic perspective, and an integrated and flexible comprehension that is not limited to specific disciplinary fields. Surely there is much to learn from this approach.

They offer various lectures every semester under six streams of Integrated Courses: Thought and Arts, International and Area Studies, Society and Institutions, Human Beings and the Environment, Matter and Life and Mathematical and Information Sciences. They provide opportunities for learning through "Thematic Courses", including lectures that probe deeply into societal issues and interdisciplinary themes from a multifaceted viewpoint, as well as small-group interactive classes. Thematic Courses can be chosen by students freely and consist of Lecture Series, Seminars and Fieldwork. Being based on the students' own enthusiasm and critical thinking, such seminars have the highest rates of student satisfaction among all of our courses. The first two years spent at the College of Arts and Sciences is a transition period from simply "studying" to the academic pursuit of "scholarship". It is a time that is not only important for deciding future directions and specialist fields, but also for establishing your own style of learning. The classrooms at Komaba campus are equipped with studio classrooms that are suitable for debate, presentation, group work and practical learning. They have even open spaces that encourage interaction

between students and staff. This is very similar to the idea behind most of the the Swedish Universities, in particular our University.

Two years for a careful consideration of future directions The University of Tokyo admits students into one of three streams in each of the sciences and the arts. After two years of Junior Division study, students progress to one of more than 40 Senior Division departments across 10 faculties, depending on suitability and individual choice.

This system of admission to the Senior Division following two years of prior study and personal growth, is a major characteristic of University of Tokyo and is built on the principle of "Late Specialization". It is a system that has wide support of the students. A majority of students said that this is their main reason for applying to this university.

Regarding the direct use of technology/It in education, it is very difficult to see how this can be implemmented directly in teaching of mathematics, or concretely in the classroom. Specific IT-programs are used directly in teaching in Tokyo in some statistic courses or in solving assignements in math courses, as e.g. Matlab. This is mainly the same as in Karlstad, where we either have labs in undergraduate courses, we use GeoGebra or, in graduate courses, the students have to use MATLAB to solve their assignements.

From the examination perspective University of Tokyo is also more flexible and it is up to the teacher to decide the examination form. It is very common with homework-assigments. In Karlstad the form of examination is controlled by the official syllabus. The students in Tokyo are more used with own video presentations, quizzes, hand-in assigments, group-work or active participation in the classroom. We implemented this alternative forms of examination in Karlstad but only in classes of small size and restrictive conditions.

In Japan, one cannot make an academic career in a university without a PhD degree and some postodoctoral positions. In these positions the teaching responsabilities are in general restricted to seminars and helping professors with examination. Traditionally, especially in top ranked universities (University of Tokyo, no exception) research merits have been prioritized, particularly in mathematics. But the reality is different, since a lot of teaching is expected of academic staff once they got a permanent position. At University of Tokyo, the teaching load is of at least six hours a week, which may mean three different courses. Many professors think that they have too much teaching and that they do not have enough time for research or supervision.

Quality teaching is crucial for student learning outcomes, retention, and overall educational experience. Since the students are very motivated and with a very good background the teachers feel also challenged. They strive to achieve a balance between being good researchers but also effective teachers, contributing to the development of students' skills and active learning.

The students who graduate at PEAK or GPEAK, but even a program in mathematics at University of Tokyo are very sought on the laber market. They find jobs in highly ranked guvernamental or non-guvernamental organizations or companies focused on sustainability and environment (very hot topics nowadays), or in universities. Most of the students find jobs even before graduating.

What it keeps teachers in this university continue with their competence developement is mainly the quality of their students and their interest in the subject matter.

As mentioned before, in Tokyo, there are organized workshops and lunch seminars on various topics such as classroom management, innovative teaching methodologies, assessment strategies.

Recommendations

All over the world the academic staff is generally busy. We also have the tendency to not get in touch to other people being afraid to not disturb them, but we have to be aware of the fact that they may think the same way. I recommend to be proactive and dare to take initiative. You can, for instance, ask the person who is responsible for you which tasks are expected from you or in which ways you can help, or your new collegues, if you can participate at their lessons, seminars or other institutional duties.

It would be very good if at least at one of the courses you would be involved in co-teaching, either helping the teacher effectively, substituting him and/or being involved in the examination. This can be planned during the preparation week. It may be tough if you will be involved in teaching by yourself in a completely new environment, with new students, in two or three courses, since the teaching load is generally six hours per week but it involves many other tasks. You may not know the preknowledge of your students or their expectations. In this way a reciprocal sharing of best practices, lesson plans and teaching ideas is most effective.

The autumn term in Tokyo starts October 1st and ends after mid January. It is also very good to be aware of the extremly byrocratic system of Japan, in general. Also, you cannot expect any organized social life as for instance, "fika" in Sweden. Taking initiave in this sense is crucial.

Action plan: Topics to address and, if possible, introduce in Sweden

I will definitively teach again the courses that I taught in Tokyo or help my collegues in charge of them, either with teaching expertise or examination. The subject matter that I gained inspires me also to find some bachelor or master thesis themes. I have already decided to introduce the "flipped classroom" in my next course *Functions of several variables* with a complementary examination. The students will work in groups of five and hand-in in the end of the lesson their exercises. I will try to introduce, at least an elective course, the course Applied Mathematics, that I developed myself. This would definitively benefit the department and the home institution. Regarding the research part, we started already to work at a common project with Professor Yoshihiro Sawano and we hope that our collaboration will be long-lasting. I think that all these teaching sabattical grants are extremely important for the Swedish education system since we have the opportunity to see how top ranked -universities are organized and function, be a part of them as well as bringing home useful experience. I will stay in touch with Profesor Jonathan Woodward. The idea is to make some on-line courses from Karlstad available for PEAK-students and viceversa. The possibility of exchange students was discussed with Oriana Sbarcea from the administration office of the Faculty of Science and I will definitely see what can be done in the future in this direction. I will also be in touch with professor Isabelle Giraudou, professor in Sustainable Sciences at PEAK who has already a collaboration with Uppsala University. This may be extended to Karlstad.

I am thankful to my university, Karlstad University, for giving me the opportunity to participate in the sabbatical teaching program, offered by STINT (The Swedish Research Foundation for International Cooperation in Research and Higher Education).

I am very thankful to the faculty and administrative staff at the University of Tokyo for making my five months of teaching sabbatical an unforgettable experience, professionaly, socialy and turistically. To make new friends from all over the world and establishing new connections is often a forgotten but so impartant part of life.

Last, but least, I would like to thank STINT (The Swedish Research Foundation for International Cooperation in Research and Higher Education) for giving me the opportunity to spend a semester at University of Tokyo, fulfilling an older dream of mine, to see a new academic culture and society.

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