Teaching Statement
Alessandro Valentino

I have always enjoyed teaching, and during the past years I have been involved in teaching activities at various levels, even when this was not a specific requirement for my academic position. Indeed, I think teaching is an invaluable formative experience, and a very challenging one as well: in particular, I find very rewarding to have the possibility of conveying the passion I have for mathematics in any material I teach. At University level, I have taught entry level classes and advanced classes. In addition, I have organized seminars and supervised students.

Teaching Philosophy

Mathematics is a difficult discipline to teach, and even more difficult to learn. I try then to interest the student in a specific problem or concept by showing him/her why the problem is relevant, and how it fits in a larger picture. This is particularly important when teaching first year students, as I have done. In this case, indeed, it is important, in my opinion, to present them mathematics as a body of knowledge based on ideas and intuitions confirmed by rigorous proof, more than as an arid set of rules to apply in a mechanical way. When asked for help, I first try to let the student himself/herself realise which part of the problem he/she does not understand. This has the effect of making the student go through the question and check that it is well posed. This practise is very important, again in particular for first year students. I try then to make the student come up with a strategy to solve the problem at hand, helping him towards the goal. In my opinion, the challenging aspect of this process is to be able not to simply supply the student with ready-made formulas to apply, but to induce him/her to come up when possible with their own result, sometimes starting from first principles. In doing this, I try to be challenging, but friendly. Indeed, I think that students should feel comfortable and at ease in asking questions, and at the same time they should realise where their mistakes are, and how to concentrate their effort in order to overcome their difficulties.

Teaching Experience

Teaching in Zürich. During the fall 2016-2017 I have been teaching a class with title "Differential Forms in Algebraic Topology", based on the book with same name by Bott and Tu. This was a full 76 hours class which I proposed and designed myself, aimed at advanced bachelor and master students as an introduction to the basic concepts of Algebraic Topology and Homotopy Theory. Topics like de Rham cohomology, sheaves, spectral sequences, homotopy groups and fibrations were discussed in such a way to give the students solid foundations to be able to follow more advanced and specialized courses in Algebraic Topology. The course was accompanied by a weekly exercise class, where complementary topics were discussed, and where the students could test their knowledge on concrete situations. A total of 7 students took part in the class, all of them taking the final exam, which consisted in a seminar chosen among a list of topics, intended as a short lecture to the other students.
At the end of the course, I decided to collect some feedback in the form of a short questionnaire which could be filled either by handwriting or electronically. In the following I report

some of the answers from different students:

What was your favourite aspect of this course?
"My favourite part was hearing about all the different approaches to study homotopy theory."

Did this class stimulate your interest in learning more about algebraic topology?
"Yes. I will definitely attend more lectures on this topic in future thanks to this lecture."

What was your favourite aspect of this course?
"Lecturer Alessandro gave us a really nice lecture. I personally liked that he explained abstract algebraic fact in a very intuitive way. Moreover he was always ready to answer student's questions."

Teaching in Hamburg. During the fall 2012 I held the position of "Vertretungsprofessur" (Stand-in Professor) for a second year course in elementary linear algebra and calculus aimed to teach students the use of computer software to solve mathematical problems. The class consisted of roughly 200 students, divided in three sections which would meet weekly in the computer lab for a total of 36 hours, and was taught in German. Though some material for the class was already available, I decided to implement my own homework exercises, which had a weekly deadline. The solutions were always provided, but with a week delay, so to give students the possibility to try to solve the exercises for themselves: in particular, I highly encouraged interaction among students, suggesting to form groups in the lab to discuss and exchange ideas. A good part of the class consisted of students enrolled in a teaching programme: I have then tried to particularly reinforce the interest in the students to explain the solutions they arrived at to their colleagues. The exam sessions were well attended, and the outcome was particularly successful.
This experience taught me a lot about entry level classes, in particular how to manage the various bureaucratic necessities, how to prepare solid class material, and how to enable a successful communication with beginner students.

During September 2012, I taught an intensive week-long class for the Master programme in Mathematical Physics, whose aim was to give master students the necessary background in algebra, differential geometry and topology. The class would meet every day for 5 hours, distributed between a morning session, where the material was introduced, and an afternoon session, where exercises where discussed. The students were coming all from different backgrounds: this required a careful choice of the material presented, which had to be tailored in order to be interesting and useful for each student, but it also required a great degree of flexibility, given that each student had different needs. Though the class did not require an exam or a grade, it taught me how to organize a consistent amount of material to be exposed in intensive sessions, and in a short time.

Teaching in Göttingen. During Spring 2009 I have been a Teaching Assistant for a course in Microlocal Analysis. Though not being close to my field of research, I enjoyed teaching this class a lot. Exercises were discussed at the blackboard: I would first expose the problem, then ask students to discuss possible solutions, and finally have one of the students solve the

exercise in detail. The atmosphere was very friendly: in particular, I tried to shorten the "distance" between the student at the blackboard and the rest, which had the effect of a more active and comfortable participation in the whole process. In particular, I also assisted with oral exams, which were given either in German or English.

During the Spring 2010 I proposed and taught my own 36 hours course, with title "Geometric methods in Algebraic Topology". This course was aimed at advanced undergraduate students, and was proposed to cover some topics which were not discussed anywhere else in the undergraduate curriculum. I prepared the entire syllabus, collected studying material, and prepared the course notes. My main idea was to provide a class in which techniques and ideas from different fields of Mathematics were needed, to encourage students to have an interdisciplinary approach to the discipline, which, according to me, is a key aspect in the research activity. Since the number of students was around 10, for the final exam I decided to give students the possibility to choose a topic, and expose it in a seminar format.

Teaching in Edinburgh. During my graduate studies, though not required by my Ph.D. scholarship, I have been a teaching assistant for classes on set theory, combinatorics, complex numbers, linear algebra, graph theory and related topics directed to mathematics and actuarial mathematics students. These were all first and second year classes, and I was responsible for following the students while working on the exercises in class, and for the weekly marking of homeworks.

Supervision

From Fall 2012 to Fall 2013, I supervised Christopher Tropp (now in Münster with a Ph.D. position). He succesfully graduated for the Master in Mathematical Physics in November 2013, with the thesis "A Serre-Swann type theorem for Gerbe Modules". The results of the thesis gave rise to a paper, which has been published on the arXiv.

After a beginning period devoted to study the necessary background material, I would meet the student Tropp weekly, we would discuss about his proposed solutions and directions at the blackboard. In particular, we would confront and analyze different possible solutions to the same problem. I made a constant effort to only give hints about the solution of the problem in advance, while spending more time on explaining the relevance of the technicality at hand in the large scale vision of project.

During this period I enjoyed the help of Prof. Christoph Schweigert, from whom I have learned how to consistently manage the whole supervision project.

Since Fall 2014, I am supervising Jan Hesse, a Ph.D. student at Hamburg University. At the moment, the doctoral student Hesse has being involved in collaborative and independent projects, which have given rise to 2 preprint submissions on arXiv. More precisely, the student has authored the paper "*Frobenius algebras and homotopy fixed points of group actions on bicategories*" together with me and Prof. Schweigert, and the paper "*An equivalence between Frobenius algebras and Calabi-Yau categories*" as a single author.

Seminar Activities

I have always been very active in organizing and partecipating to graduate seminar activities.

In Edinburgh, I was among the founders of the "*Mathematical Physics Speakers' Corner*", a weekly activity where graduate students had the possibilty of exposing their own reasearch,

or a mathematics/physics topic they found particularly interesting. Moreover, during the year 2005-2006 I helped organize a Journal Club on advanced topics in String Theory, as an activity for the Edinburgh Mathematical Physics Group.

In Göttingen, I organized a small reading class on *"Index theory and Differential K-theory"*, where lectures were given by the students themselves.

In Hamburg I have been very engaged in the Research Seminar activity in the group of Prof. Schweigert. This involved giving talks, and in more than one occasion taking charge of the research topic, scheduling the seminars, and assisting the graduate students during the preparation of their talks.

In the fall 2015 I have co-organised with Owen Gwilliam at Max Planck Institute the seminar *"Topology in Condensed Matter"*, aimed as an introduction to the application of topology to solid state physics, most relevantly to topological insulators.