Curriculum Vitae

Jakob Jonsson

June 11, 2010

1 Personal Data

1.1 Name

Nils JAKOB Jonsson

1.2 Date of birth

September 14, 1972.

1.3 Male of female?

Male.

1.4 Living address and phone number

Götaforsvägen 17, 1 tr
122 66 Enskede

08-647 79 36
070-938 72 15

1.5 Address, phone number and email to place of work

Institutionen för matematik
KTH
10044 Stockholm

08-790 72 02
jakobj@kth.se

1.6 Present employment

Forskarassistent (research assistant) at KTH, 67% funded by Vetenskapsrådet (Swedish Research Council) and 33% funded by KTH.

Project title:
Interactions between topological combinatorics and other fields of mathematics

Date of appointment: July 1, 2007.

1.7 Previous periods of employment

Teaching experience is indicated whenever applicable.

7/06 – 6/07	Instructor in applied mathematics. *Massachusetts Institute of Technology (MIT), Cambridge, MA.* Research in combinatorics. Teaching assistant on two undergraduate courses.
3/06 – 7/06	Post-doctoral position in mathematics. *Technische Universität Berlin, Germany.* Research in combinatorics. Financed by Prof. Günter Ziegler's Leibniz Preis.
1/06 – 3/06	Post-doctoral position in mathematics. *Institut Mittag-Leffler, Djursholm, Sweden.* Research within the program in Algebraic Topology.
7/05 – 12/05	Post-doctoral position in mathematics. *Technische Universität Berlin.* Research in combinatorics. Within the European Graduate Program "Combinatorics, Geometry, and Computation."
9/03 – 6/05	Graduate student in mathematics. *KTH, Stockholm.* Graduate studies (80%). Teaching assistant (20%).
9/02 – 8/03	Pre-doctoral position in mathematics. *Philipps-Universität Marburg.* Graduate studies. Within the Research Training Network "Algebraic Combinatorics in Europe."
9/99 – 8/02	Research staff position. *RSA Laboratories Europe, RSA Security, Stockholm.* Research and standardization in cryptography. Part time first six months.
7/97 – 3/00	Graduate student in mathematics. *Stockholms universitet.* Graduate studies: 80%. Teaching: 20%. Part time last six months.

2 Degrees, Assessments and Evaluations

2.1 Academic degrees including year of graduation

Degree	Filosofie doktor (Doctor of Philosophy)
Year	2005
School	Department of Mathematics, KTH, Stockholm
Title of thesis	*Simplicial Complexes of Graphs*
Advisor	Professor Anders Björner
Areas of study	Topological and algebraic combinatorics

Degree	Filosofie licentiat (Licentiate of Philosophy)
Year	1999
School	Department of Mathematics, Stockholms universitet
Title of thesis	*Euler Trails and Trees in Directed Graphs*
Advisor	Svante Linusson (now Professor at KTH)
Areas of study	Algebraic combinatorics and graph theory

2.2 Conferment of the title of docent

My intention is to apply for the title of docent the upcoming fall. This spring I have taken the required course *LH207V, Research Supervision, 3 hp* at the KTH Learning Lab.

3 Scientific Achievements

3.1 Brief account of own research profile

In the following account, I will mostly discuss more recent work, only briefly mentioning work dating back more than five years. For references, see Section 3.3.

I have been conducting research in combinatorics, and my focus has been on the subfield of topological combinatorics. Much of my research has evolved around combinatorially defined simplicial complexes, and my main goals have been to analyze the homotopy type, homology and Euler characteristic of such complexes. Topological combinatorics has found applications in such diverse areas as knot theory, statistical physics and commutative algebra, and the connections often go via simplicial complexes. In particular, the field is of importance not only to combinatorialists but also to mathematicians in general.

During my time as a doctoral student, I examined monotone graph properties. A graph property on a given finite set V is a family of graphs on the vertex set V such that the family is closed under permutations of the vertices. The property is monotone if it forms an abstract simplicial complex. In my doctoral thesis from 2005 (see Section 2.1), I summarized known results about the topology of specific monotone graph properties, such as the properties of being disconnected, not 2-connected, acyclic and bipartite. My own set of contributions included new results about the properties of being not 3-connected, non-Hamiltonian and p-coverable [M2, M5]. In 2008, Springer published a revised version of the thesis in the *Lecture Notes in Mathematics* series; see Section 3.3.2. In the revised version, I included some new results about the matching and chessboard complexes [M9, M10, M14].

Let me discuss the matching complex in some detail. This complex is defined in terms of a finite ground set V, and the vertices are identified with the subsets of V of size two. A set of vertices forms a face if and only if the vertices are pairwise disjoint. The rational homology is well-known (Serge Bouc), but the integral homology is only partially investigated. John Shareshian and Michelle Wachs proved that the bottom nonvanishing homology group is an elementary 3-group for all sufficiently large ground sets. I extended their result by proving that almost all nonvanishing homology groups of the matching complex contain 3-torsion (elements of order 3). I also obtained upper bounds on the order of some of these homology groups [M9]. More recently, I have focused on looking for p-torsion for other primes p, and I have found such torsion for p equal to 5, 7, 11, and 13 [M10, M16]. An important ingredient in my proofs has been the theory of group actions on simplicial complexes.

A completely different line of research pertains to independence complexes of square grids. The independence complex of a loopless graph is a simplicial complex with the same vertex set as the graph. A set of vertices forms a face if and only if no two vertices are joined by an edge. I have studied independence complexes of square grids embedded on cylinders and flat tori. In the former case, we have horizontal periodic boundary conditions; in the latter case, we have both horizontal and vertical periodic boundary conditions. My main result relates the Euler characteristic in the toric case with certain rhombus tilings of the plane [M7]. A consequence of my result is a proof of a conjecture in statistical physics due to Paul Fendley, Kareljan Schoutens and Hendrik van

Eerten. Specifically, for fixed m, one may use a transfer matrix to generate the Euler characteristic of the $m \times n$ toric grid for all n. My result implies that all eigenvalues of this matrix are roots of unity. In the cylindrical case, I prove that the Euler characteristic is very small whenever the circumference of the cylinder is odd [M11].

The main ingredient in my proofs is the construction of a pairing of faces of the given independence complex such that each pair consists of one face of odd dimension and one face of even dimension. Removing all such pairs, one obtains a family with the same Euler characteristic as the original complex. While my construction does not admit a topological interpretation, there are obvious similarities with typical combinatorial applications of Robin Forman's discrete Morse theory. This theory formed an integral part of my early research [M2, M5, M6], and it does show up also in more recent work. For example, Axel Hultman and I used discrete Morse theory to compute the integral homology of a certain manifold defined in terms of matrices of Barvinok rank two [M15]. The Barvinok rank appears in the context of tropical geometry.

While my emphasis has been on simplicial complexes, I have also looked at more general cell complexes. Such complexes do appear naturally in my applications of discrete Morse theory; the main goal of the theory is to transform a given simplicial complex into a cell complex with the same homotopy type and with a less complicated structure. In this work, we fix a partially ordered set P, and we form a cell complex in which each cell is indexed by a word formed by distinct elements from P such that the order of appearance of the elements in the word aligns with the partial order of P. Our main result is that (the barycentric subdivision of) the resulting cell complex is always Cohen-Macaulay.

3.2 Brief account of planned research effort

It is difficult to predict the future in mathematical research, as it is hard to tell in advance whether a given project will be fruitful. The following account gives two examples of projects that I already initiated and plan to pursue the upcoming year. The projects are open-ended in the sense that it is impossible to tell whether I will be successful in achieving my goals. At the same time, there are certainly interesting problems in both projects that I already solved or know that I can solve.

One of the most important classes of simplicial complexes is the class of Cohen-Macaulay complexes. The importance is partly due to the Stanley-Reisner connection to commutative algebra; a given simplicial complex is Cohen-Macaulay if and only if a certain associated monomial ideal is Cohen-Macaulay in the algebraic sense. Moreover, the class of Cohen-Macaulay complexes contains the subclass of pure shellable complexes.

One of my future goals is to examine further aspects of Cohen-Macaulayness. An old conjecture, due to Richard Stanley, states that every Cohen-Macaulay complex is partitionable. This means that we may partition the complex into as many intervals as there are maximal faces of the complex; an interval is a family of the form $\{\rho : \sigma \subseteq \rho \subseteq \tau\}$. The conjecture is trivially true for shellable complexes; the very definition of shellability implies partitionability. Yet, for arbitrary Cohen-Macaulay complexes, the conjecture remains wide open.

In a recently started project, I interpret the property of being partitionable in terms of certain cell complexes. Specifically, I have introduced the concept of an *interval map* between two partially ordered sets. Such a map is defined by the property that the inverse image of every interval is again an interval. One may express the property of being partitionable in terms of the existence of an interval map from the simplicial complex under consideration to the antichain of size the number of maximal faces of the complex. This is analogous to a graph being m-colorable if and only if there is a graph homomorphism from the graph to the complete graph K_m on m vertices.

Indeed, inspired by the Hom-complex construction of László Lovász in terms of homomorphisms between two graphs, I have defined a cell complex in terms of interval maps between two partially ordered sets. I have some preliminary homological results suggesting that cell complexes defined in terms of interval maps from the 3-chain might be potentially useful when analyzing the partitionability of partially ordered sets. This would mean that the 3-chain plays a role similar to the role played by the complete graph K_2 in Lovász' work.

The ultimate goal would be to use the approach outlined above to obtain new insights into the conjecture of Stanley. The approach is probably more likely to be useful for producing a counterexample than a proof. Even if the goal turns out to be unachievable, I believe the theory of interval maps might be of interest in its own right.

For the time being, the theory is more simple-minded than the corresponding theory for graph homomorphisms developed by Eric Babson, Dmitry Kozlov, Carsten Schultz and others. One further goal would be to develop and refine the theory, focusing on achieving more elegant topological characterizations of partitionability.

In another ongoing project, I am working on Mikhail Kapranov's generalization of homology theory. In this generalization, the equation $d^2 = 0$ for the boundary operator d is replaced with the equation $d^n = 0$ for some fixed integer n, and one studies the generalized homology groups $\ker d^k / \mathrm{im}\, d^{n-k}$ for $1 \le k \le n$. The analysis of these generalized homology groups has been a quite active research field in recent years, especially among theoretical physicists. My main observation so far is that Forman's discrete Morse theory admits a generalization to Kapranov's setting. I have also examined refinements of the generalized homology groups. In the case that d is a nilpotent operator on a finite-dimensional vector space, it is well-known that one may express the ranks of these refined homology groups in terms of the Jordan decomposition of d. I have been able to extend this observation to operators on arbitrary groups.

So far, my discoveries are quite theoretical in nature. The real challenge will be to find interesting applications. I am particularly eager to apply my generalization of discrete Morse theory. There are indeed applications, but they are already well investigated by Michel Dubois-Violette and others. Another of my goals is to get better acquainted with the connections to theoretical physics.

3.3 List of publications

3.3.1 Papers published in internationally reputed periodicals which have been subject to referees' assessment

[M16] More Torsion in the Homology of the Matching Complex, *Experimental Mathematics*, accepted.

[M15] The Topology of the Space of Matrices of Barvinok Rank Two, joint work with Axel Hultman, *Beiträge zur Algebra und Geometrie*, accepted.

[M14] On the 3-Torsion Part of the Homology of the Chessboard Complex, *Annals of Combinatorics*, accepted.

[M13] Certain homology cycles of the independence complex of grid graphs, *Discrete and Computational Geometry* **43** (2010), No. 4, 927–950.

[M12] Complexes of Injective Words and Their Commutation Classes, joint work with Volkmar Welker, *Pacific Journal of Mathematics* **243** (2009), no. 2, 313–329.

[M11] Hard Squares with Negative Activity on Cylinders with Odd Circumference, *Electronic Journal of Combinatorics* **16** (2009), no. 2, R5.
(Special volume in honor of Anders Björner on the occasion of his 60th birtday.)

[M10] Five-Torsion in the Homology of the Matching Complex on 14 Vertices, *Journal of Algebraic Combinatorics* **29** (2009), no. 1, 81–90.

[M9] Exact Sequences for the Homology of the Matching Complex, *Journal of Combinatorial Theory, Series A* **115** (2008), 1504-1526.

[M8] A Spherical Initial Ideal for Pfaffians, joint work with Volkmar Welker, *Illinois Journal of Mathematics* **51** (2007), no. 4, 1397–1407.

[M7] Hard squares of negative activity and rhombus tilings of the plane, *Electronic Journal of Combinatorics* **13** (1) (2006), #R67, 41 pages.

[M6] Optimal Decision Trees on Simplicial Complexes, *Electronic J. Combin.* **12** (2005), no. 1, R3.

[M5] Simplicial Complexes of Graphs and Hypergraphs with a Bounded Covering Number, *SIAM J. Discrete Math.*, **19** (2005), no. 3, 633–650.

[M4] The Topology of the Coloring Complex, *J. Algebraic Combin.* **21** (2005), no. 3, 311–329.

[M3] Generalized Triangulations and Diagonal-Free Subsets of Stack Polyominoes, *J. Combin. Theory, Ser. A* **112** (2005), 117–142.

[M2] On the Topology of Simplicial Complexes Related to 3-Connected and Hamiltonian Graphs, *J. Combin. Theory, Ser. A* **104** (2003), no. 1, 169–199.

[M1] On the number of Euler trails in directed graphs, *Math. Scand.* **90** (2002), no. 2, 191–214.

More information: http://www.math.kth.se/∼jakobj/research.html

3.3.2 Other publications, including books

A revised version of my doctoral thesis, *Simplicial Complexes of Graphs*, has been published as *Lecture Notes in Mathematics* 1928, Springer, 2008.
More information: http://www.math.kth.se/∼jakobj/thesis.html

I worked in the field of cryptography for three years between 1999 and 2002. My work resulted in the following conference papers and published documents:

[C7] Securing RSA-KEM via the AES, joint work with Matt Robshaw, *Proceedings from Public Key Cryptography – PKC 2005*, Springer, 2005, 29–46.

[C6] On the security of CTR + CBC-MAC, *Proceedings from Selected Areas of Cryptography – SAC 2002*, Springer, 2002, 76–93.

[C5] On the security of RSA encryption in TLS, joint work with Burt Kaliski, *Advances in Cryptography – CRYPTO 2002*, Springer, 127–142.

[C4] Cryptanalysis of the NTRU Signature Scheme (NSS) from Eurocrypt 2001, joint work with Craig Gentry, Michael Szydlo, and Jacques Stern, *Advances in Cryptography – ASIACRYPT 2001*, 1–20.

[C3] Security proofs for the RSA-PSS Signature Scheme and its variants, *Second open NESSIE Workshop*, Royal Holloway, Egham, September 2001.

[C2] *PKCS #1 v2.1 – RSA Cryptography Standard*, joint work with Burt Kaliski, RSA Security, 2002.

[C1] *RSA Laboratories' Frequently Asked Questions About Today's Cryptography, version 4.1* (technical editor), RSA Security, 2000.

Papers C3-C7 were all published in peer-reviewed conference proceedings.

More information: www.math.kth.se/~jakobj/crypto.html

3.4 Grants which have been appropriated

3.4.1 Research council funds

My position as forskarassistent (research assistant) is funded by Vetenskapsrådet (Swedish Research Council); see Section 1.6. Associated to the position is a projektbidrag (project grant) distributed over the years as follows (amounts in SEK):

2007	2008	2009	2010
53,000	38,000	38,000	38 000

3.5 Other scientific achievements

3.5.1 Active participation in national and international conferences in the last 5 years

I was a member of the program committee for the 2010 conference on Formal Power Series & Algebraic Combinatorics (FPSAC). My task was to evaluate ten submissions to the conference.
http://math.sfsu.edu/fpsac/committees.php

I was an invited speaker at the following conferences:

2006 Fall Eastern Section Meeting, Special Session on Algebraic and Analytic Combinatorics, Storrs, CT, October 28-29, 2006. Organizers: Richard Ehrenborg and Margaret A. Readdy.
http://www.ams.org/meetings/sectional/2133_program_ss11.html

Festive Combinatorics in honor of Anders Björner's 60th birthday, May 28-30, 2008, KTH, Stockholm. Organizers: Kimmo Eriksson, Axel Hultman, Svante Linusson, Günter M. Ziegler.
http://www.math.kth.se/bjorner60/

I also gave a presentation at the *5th Workshop on Combinatorics, Geometry, and Computation*, Hiddensee, September 25-28, 2005. This workshop was organized within the framework of the European Graduate Program *Combinatorics, Geometry, and Computation*.
http://www.inf.fu-berlin.de/graduate-programs/cgc/Veranstaltungen/Workshops/Annual_05/abstracts.pdf

3.5.2 National and international awards

Strömer-Ferrnerska belöningen (30,000 SEK), April 9, 2008.
http://www.kva.se/en/pressroom/press-releases-2008-2001/Svenska-forskare-belonas-for-forskningsinsatser/

3.5.3 Review / referee assignments by international periodicals

In the last five years, I have been an anonymous referee for 37 manuscripts (7-8 manuscripts per year) for the following 20 journals:

Name of Journal	Assignments
Advances in Applied Mathematics	1
Advances in Mathematics	2
Arkiv för matematik	2
Ars Combinatoria	1
Combinatorica	1
Discrete Applied Mathematics	1
Discrete Mathematics	4
Electronic Geometry Models	1
Electronic Journal of Combinatorics	3
European Journal of Combinatorics	3
Hamburger Abhandlungen	1
International Mathematics Research Notices	1
Israel Journal of Mathematics	1
Journal of Algebra	1
Journal of Algebraic Combinatorics	2
Journal of Combinatorial Theory, Series A	6
Journal of Integer Sequences	1
Mathematics of Operational Research	1
Topology and its Applications	2
Transactions of the AMS	2

3.5.4 Assignments as public examiner/opponent

I have been the external examiner (diskutant) for the Licentiate Degree on three occasions:

Johan Thapper, *Combinatorial Considerations on Two models from Statistical Mechanics*, Linköpings universitet, November 16, 2007.
Supervisor: Svante Linusson.

Eric Emtander, *On Hypergraph Algebras*, Stockholms universitet, April 21, 2008.
Supervisors: Jörgen Backelin and Ralf Fröberg.

Ragnar Freij, *Enumeration on Words, Complexes and Polytopes*, Chalmers tekniska högskola & Göteborgs universitet, April 22, 2010.
Supervisors: Johan Wästlund and Niklas Eriksen.

3.5.5 Assignments as outside expert

I was or will be a member of the evaluation committe for the following two thesis defenses:

Vincent Pilaud, *Multitriangulations, Pseudotriangulations and Some Problems of Realization of Polytopes*, Université Paris Diderot (Paris 7), May 31, 2010.
Supervisors: Michel Pocchiola and Francisco Santos.
http://people.math.jussieu.fr/∼vpilaud/these/

Liza Huijse, *A Supersymmetric Model for Lattice Fermions*, Universiteit van Amsterdam, June 18, 2010.

Supervisor: Kareljan Schoutens.

I was one of two external (non-anonymous) referees for Vincent Pilaud's thesis.

3.6 Scientific qualifications of a non-academic nature

Not during the last five years. Between 1999 and 2002, I worked as a researcher in cryptography at the Stockholm branch of RSA Security, a Massachusetts-based computer security company.

4 PEDAGOGICAL ACHIEVEMENTS

4.1 Account of own pedagogical experience

I have been involved in educational activities since I started as a graduate student back in 1997. For a total of four years during my graduate studies (1997-2000 at Stockholms universitet and 2003-2005 at KTH), I spent 20% of my work time on education. My tasks were mainly to give classes as an assistant teacher and to help students individually during and outside classes. I also helped correcting exams. All courses were on an undergraduate level.

I spent the fall of 2006 and the spring of 2007 at MIT (see Section 1.7), where I had similar responsibilities.

During my time as a research assistant at KTH, I have spent 33% on teaching. I have been responsible for two courses, both on an advanced undergraduate level. In both cases, I was the only teacher involved. The first course was *SF2715 Tillämpad kombinatorik* (Applied Combinatorics), which I gave in Spring 2009. The second course was *SF2714 Discrete Mathematics and Algebra*, which I gave in Fall 2009. Each course involved around 20 or 25 students. The latter course was given in English.

In Fall 2010, I will have the main responsibility for SF1624 Algebra och geometri for Maskinteknik (Mechanical Engineering), a course with more than 100 students. I will also give a course in topological combinatorics for graduate students.

4.2 Personal pedagogical ideas about teaching

Before going into detail on my ideas, let me give a short summary of what I find most important in learning and teaching.

- As a teacher, it is of vital importance to spend considerable time and effort on preparations, both for the course itself and for the components of the course (lectures, classes, assignments, and so on). My experience is that there is a very strong correlation between the time spent on preparations and the quality of the outcome.

- It is important to view the course from the perspective of the students and to design the course according to their needs. The focus should be on the student, not on the teacher.

- When assessing the performances of the students, the teacher needs to be fair and also make sure that the students who reach the pass grade indeed acquired the desired level of knowledge.

I now proceed with a more detailed account. Some of my ideas are based on experience from the two courses that I gave during the year 2009; see Sections 4.1 and 4.3.

Perhaps the most important part of the course is the preparatory work, before the course starts. This is the part where the teacher decides on the syllabus, the course outline, the tasks for the students, and the assessment method.

As for the syllabus, my approach has been to examine each potential topic of the course from the perspective of a student:

- The topic should be relevant and potentially useful for the student, either within the course or from a wider perspective (e.g., within the student's study program). I try to keep mere curiosities and dead ends to a bare mininum.

- The topic should be accessible to the student, not just in terms of learning the important equations, but also in terms of learning the underlying theory.

- It should be possible to assess the student's knowledge of the topic in a reasonable manner.

In addition, it is important to check that the time the student will need to invest in the course as a whole aligns with the credits given for the course. In particular, one should avoid the common mistake of including too much material in the course.

Before the course starts, one should also prepare a course plan with detailed information about all lectures and classes during the course. There should be room for some flexibility, but dates should be fixed for the most crucial parts of the course. All important information should be posted on the course web page: course objectives, syllabus, course plan, literature, assessment method, and important dates.

I am a proponent of a soft start. During the first meeting with the students, I think it is important to spend quite some time on outlining the course and discussing all important practical matters. Outlining a course is difficult and requires careful preparations to avoid being too technical or too vague. The latter may actually be worse than the former, as a vague outline may give the students the wrong ideas about the course. During the first meeting, one may also hand out a survey with questions about the students' backgrounds and areas of interest. Again, this requires careful preparations to avoid ambiguous responses from the students.

When preparing a lecture, one needs to take into account that the students may have very different backgrounds. Finding a level that suits all students is very tricky, if at all possible. My personal approach is to set the level somewhere in between, making the greater part of the lecture accessible to the vast majority of the students and then spending a smaller part on more advanced material.

The teacher should make sure to spend enough time on the course and not postpone important tasks without reason. The teacher should keep the course webpage up to date with the most recent information, and the teacher should also correct assignments and exams within reasonable time. This is to show the students due respect and let them know that their teacher gives priority to and engages in the course.

Given the asymmetric relationship between student and teacher, it is of crucial importance to treat the students politely and respectfully and to avoid sarcasm and patronizing comments. Of course, this does not mean that one should give way for unreasonable demands from students, such as requirements of a higher, undeserved grade. Still, even in such situations, one should keep being polite and carefully explain why the demands are not reasonable.

This brings us to the subject of assessment and grading. What is most important for the teacher is consistency and fairness. One should be unbiased and avoid taking into account general impressions of the students while correcting assignments and exams. In practice, this is not always straightforward to obtain; we tend to be more prejudiced and biased than we think we are. One possibility would be to use an external examiner, i.e., a person who is not acquainted with the students. The external examiner could be either from another university or a colleague at the same department. It might take a while to implement such a system, but in the long run I think it would be an improvement.

Most undergraduate courses in mathematics end with a final exam. While this form of examination certainly has its drawbacks, I do find it acceptable and have used it myself in my own courses. Unless stress handling is supposed to be part of the examination (rarely the case in mathematics), I find it important that there is enough time for the students to ponder the exam problems. The design of the exam requires careful thought. Ideally, the exam should satisfy the potentially conflicting properties of being unpredictable, falling within the scope of the course, being well-balanced with respect to the syllabus, and aligning with the desired learning objectives.

As everybody knows, students tend to postpone their studies until the end of the course, especially if there is no other examination than a final exam. A popular solution to this problem is to spread the examination over the course, adopting a system with smaller exams or home assignments during the course. Personally, I am not particularly fond of mid-course exams. Writing an exam under time pressure is a stressful situation, and things become even more stressful if the exam takes place in the middle of the learning process. From that perspective, home assignments are preferable. The students are given more time to formulate their solutions and may focus more on understanding the theory and less on memorizing formulas and equations.

One downside of mid-term examination shows up in the final grading. A common method, used by myself in my own courses, is to translate the students' performances into bonus points added to the score on the final exam. Yet, such a system has it weaknesses and needs to be used with some caution. Specifically, bonus points must not compensate for a substandard final exam. For a pass grade, we should always require a decent performance on the final exam. For this reason, maybe the final exam alone should decide on the pass grade. The bonus points would then only count towards the higher grades.

Some of my ideas have their origin in the book *Teaching for Quality Learning at University* by John Biggs and Catherine Tang. The book was used at the pedagogical course that I took during Spring 2009; see Section 4.6. What I found particularly helpful was the emphasis on the student's perspective and the structured approach to course design. I did use some of the authors' theories when planning my own courses.

Finally, I would like to present some general thoughts on courses in mathematics. I think theory deserves a central position in all university courses in the subject. My impression is that things are shifting in the opposite direction; more time is spent on practicing computing skills, while the underlying theory is put aside. I find this development unfortunate. The students do learn to solve computationally complex problems using formulas and equations, but they have a hard time adapting their knowledge to problems that are less conventional than those in the textbooks. With a more thorough theoretical education, the students will improve their ability to solve unconventional problems.

4.3 Own teaching effort

During the last five years, I have been involved in courses at MIT and KTH. At MIT, I taught the following courses:

- 18.022 Calculus, Fall 2006. This is a first course in vector calculus aimed at students with a strong mathematical background.

  I was responsible for recitations in two classes, meaning that I worked as a teaching assistant in those classes. My weekly teaching load was 4×50 minutes. I also helped correcting exams. The course leader was Lars Hesselholt.

- 18.02 Calculus, Spring 2007. This is again a first course in vector calculus but aimed at students with a more average mathematical background.

  My responsibilities were exactly the same as in the previous course. The course leader was Gigliola Staffilani.
  http://web.mit.edu/lcevans/www/18.02/

At KTH, I have been involved in the following courses:

- SF1617 Matematiska metoder II (12 hp), Spring 2008. This was a first course in linear algebra and vector calculus for students at the program of Samhällsbyggnad (Civil Engineering and Urban Management).

  I was the teaching assistant for one class. My responsibilities included giving lectures about parts of the theory. My teaching load was 48×90 minutes (4×90 minutes over 12 weeks). I also helped correcting mid-course exams ("kontrollskrivningar") and the final exam. The course leader was Göran Hulth.
  http://www.math.kth.se/math/GRU/2007.2008/SF1617/

- SF1658 Trigonometri and funktioner (7.5 hp), Fall 2008 and Fall 2009. This is a first course in trigonometry and calculus for Samhällsbyggnad.

  Both years, I was the teaching assistant for one class, and the teaching load was 13×90 minutes. Both years, I was also involved in two oral examinations, which required around 2×4 hours of work, and I helped correcting the final exam. The course leader was Roy Skjelnes.
  http://www.math.kth.se/math/GRU/2008.2009/SF1658/
  http://www.math.kth.se/∼skjelnes/KURS/SF1658.0910/

- SF1625 Envariabelanalys (7.5 hp), Fall 2008. This is a first course in calculus for Samhällsbyggnad.

  I was the teaching assistant for one class. The teaching load was 12×90 minutes. I also helped correcting mid-course exams and the final exam. The course leader was Göran Hulth.
  http://www.math.kth.se/math/GRU/2008.2009/SF1625/CSAMH/

- SF2715 Tillämpad kombinatorik (6 hp), Spring 2009. This is an advanced undergraduate course in combinatorics aimed mainly at students at the programs of Datateknik (Computer Science and Technology) and Teknisk fysik (Engineering Physics).

I was the course leader and the only teacher involved in the course. This was an already existing course, and my preparations mainly consisted in going over the syllabus and course literature (which indeed resulted in a number of changes). Due to an almost total lack of suitable exercises in the course book, I also spent considerable time producing supplementary material with exercises; see Section 4.4. There were a total of 18 lectures, each 2×45 minutes. The examination consisted of four home assignments and a final exam.
http://www.math.kth.se/math/GRU/2008.2009/SF2715/

- SF2714 Discrete Mathematics and Algebra (7.5 hp), Fall 2009. This is an advanced undergraduate course in combinatorics and algebra aimed mainly at international Master students at KTH.

  I was the course leader and the only teacher involved in the course. Similarly to SF2715, this was an already existing course, but I made a major revision of the syllabus before the course started. There were a total of 18 lectures, each 2×45 minutes. For each lecture, I produced lecture notes that I posted on the webpage; see Section 4.4. One reason for doing so was that quite a few of the students were unable to attend several of the lectures. The examination consisted of two home assignments and a final exam.
  http://www.math.kth.se/math/GRU/2009.2010/SF2714/TMTHM

4.4 Design of own course materials

For my course *SF2715 Tillämpad kombinatorik* (Spring 2009), I designed 70 pages of supplementary material, mainly consisting of exercises.
http://www.math.kth.se/math/GRU/2008.2009/SF2715 → Kurslitteratur

For my course *SF2714 Discrete Mathematics and Algebra* (Fall 2009), I posted electronic lecture notes to the course webpage after each lecture.
http://www.math.kth.se/math/GRU/2009.2010/SF2714/TMTHM → Literature

See Section 4.3 for more information about the courses.

4.5 Pedagogical development effort

While doing voluntary work at the 2010 edition of Matematikbiennalen, I attended a number of seminars on the didactics of mathematics.

4.6 Own pedagogical education

Finished courses:

Spring 2009: LH201V Learning and Teaching. Credits: 7.5 hp.

Spring 2010: LH207V Research Supervision. Credits: 3 hp.

4.7 Academic supervising experience

4.7.1 Degree project works

I was the supervisor of Jakob Skwarski, who presented his Master's Project (examensarbete) in June 2010.

I was also the supervisor of Chen Xing and Simon Meuller, who presented their Bachelor's Thesis (kandidatexamensarbete) in May 2010.

4.7.2 Licentiate and/or doctoral students

I was the assistant supervisor of Alexander Engström between 2007 and 2009. He received his doctoral degree in Spring 2009. Svante Linusson was the main supervisor.