technopolis group

May 2025

Evaluation of the Research Part of the University of Luxembourg: Evaluation Report

Department of Mathematics (DMATH)

May 2025

Evaluation of the Research Part of the University of Luxembourg: Evaluation Report

Department of Mathematics (DMATH)

Matthias Schuett, Jeanine Duistermaat, Philippe Michel, Wei Ho, Andreas Kyprianou

Executive Summary

The Department of Mathematics is a relatively small but very strong unit of importance for the University and Luxembourg. It conducts fundamental research with increasing interdisciplinary applications based on the individual researchers' widely recognised expertise. It is organised into thematic research groups producing high quality research of big relevance and international visibility. The unit is very successful in acquiring competitive funding on national and international level, although the excellence of the individual researchers is not yet fully reflected in the European funding record.

The impact of the department's research is visible in its great publications, reaching the very top journals, and in organising international research activities attracting worldwide attention. It features in the outstanding success in training early career researchers, preparing them in an exceptional way for a career in academia or industry. In a larger context, this can be viewed as a sign of the department's commitment to higher education, supplemented by excellent teaching credentials and steeply rising student numbers, not the least thanks to a newly established topical master programme in data science.

This new study programme came with the creation of a new research direction in Data Science and Statistics, which shows the flexibility of the department in reacting to the latest developments in research and society. The main strategy of the department for the years to come is to build on its existing strengths, notably in geometry and probability, mostly through the acquisition of substantial external funding, while further growing in applied mathematics in the areas of data science and partial differential equations, based on the latest strategic hiring. To achieve this, a detailed hiring plan is in place, incorporating retirements and replacements as well as new positions per the next two four year plans of UL. However, the implementation of such plans requires a more proactive strategy than seems currently to be pursued. This is surprising as the department was extremely successful with its latest hirings, attracting excellent researchers from all over the world while improving substantially on gender balance.

The department is on a steep trajectory in improving interdisciplinary collaborations. This has resulted in increasing societal impact, while leaving scope for doing more to connect to the focal areas of UL and to the national priorities. It is also reflected in the department's outstanding efforts in outreach, both on the national and international scale.

Recommendations

- The department should be more proactive in capitalising on the individual researcher's excellence by pursuing high profile European grants, and in implementing their strategic hiring plans, given the support of UL.
- It should invest in interdisciplinary collaborations, especially with industry, but also by connecting more flexibly to the national priorities.
- The department should work together with the university to set up a sustainable financial scheme allowing for reliable personnel planning and thus avoiding untimely disruptions of the small groups at the limit of their capacities for teaching and research.
- Communication should be improved among department, university leaders and administration.
- The university leadership and the Ministry should re-assess current rules for sabbaticals, joint supervision of PhD students, and parental leave.

In summary, with additional support there is high potential for many more high impact contributions to society and groundbreaking research.

Table of Contents

1 Introduction and background

1.1 Introduction to the evaluation

The Ministry of Research and Higher Education (MESR) of Luxembourg has mandated Technopolis Group to evaluate of the research part of the University of Luxembourg. This evaluation was conducted from May 2024 to June 2025. According to Art. 50/2 of the modified law on the organisation of the University of Luxembourg of June 27th, 2018, based on the original law of 2003, the University is subject to external evaluation every four years. The present evaluation assesses both the research and institutional aspects of the University[1]. The main period to be covered by this exercise is 2018-2023. Next to a retrospective assessment of achievements, the evaluation's prospective elements include the evaluation of the strategies and plans of the University as well as the evaluators and the panel assessment of challenges and opportunities ahead.

The University's mission, as defined by law, is threefold: to offer higher education courses leading to degrees, diplomas and certificates; to conduct research; and to contribute to the social, cultural and economic development of Luxembourg.

This report is part of the assessment of the research performance of the Universities' 13 research departments and three interdisciplinary centres and covers the Department of Mathematics in the Faculty of Science, Technology and Medicine. The evaluation is based on international external peer review and covers the performance of the research department, considering aspects such as inputs (e.g., finances, human resources, infrastructure, strategy) and outputs/impacts (e.g., research outcomes, innovation activities, services). A separate report covers the assessment of organisation, management, and governance of the university as a whole.

The observations and recommendations presented in this report are based on a peer review by the following experts, who work in the department's research fields:

- Prof Matthias Schuett, Leibnitz University Hannover (chair)
- Prof Jeanine Duistermaat, Radboud University
- Prof Philippe Michel, EPFL
- Prof Wei Ho, Institute for Advanced Study, Princeton (remote reviewer)
- Prof Andreas Kyprianou, University of Warwick (remote reviewer)

The assessment is based on a self-evaluation report submitted by the department, background information on the Luxembourg research system information provided by Technopolis Group, and an on-site visit to the department in January 2025. The visit, which was organised and moderated by Technopolis, consisted of self-presentations by the research unit and its six research groups, as well as group interviews with external partners and clients.

The expert panel applied the following evaluation criteria and organised the present report accordingly: quality of the research, impact of the research (third mission), and future potential of the research in the department.

[1] The external evaluation of the University covers teaching and research activities, central administration and internal organisation. The focus alternates between research and education. All evaluation reports are published by the Ministry. https://mesr.gouvernement.lu/fr/dossiers/dossiers/rapports-d-evaluations.html

The evaluation team would like to thank all those who helped them prepare the evaluation, those who provided information and those who were interviewed.

1.2 The Department

The Department of Mathematics is part of the Faculty of Science, Technology and Medicine. It has 17 small research groups distributed across six research areas: (1) Algebra and Number Theory, (2) Geometry and Topology, (3) Probability and Stochastic Analysis, (4) Discrete and Geometric Analysis, and (5) Statistics and Data Science (6) Partial Differential Equations and Modelling.

According to its self-evaluation report, the department's 2023 research income was some €7.7m. Of this, 59% was institutional funding, 33% was provided by FNR and 8% came from other sources abroad – almost all from the EU Framework Programme. External, competitive funding rose both in absolute terms and from 25% to 41% of the research income between 2018 and 2023.

The academic staff of the department comprised 12 full professors, two associate professors and 2 assistant professors, as well as 30 postdocs. There were 34 PhD students of whom 5 graduated during the year. The number of PhD students grew from 25 in 2018 to 34 in 2023.

2 Research strategy and organisation

The department maintains a world class profile and does high-impact research that shows it is well embedded in the international research landscape. This is remarkable given the department's relatively small size, and testifies to its very good organisation. It has a flat hierarchy appropriate to the research conducted and the excellent composition of its staff, fostering the great team spirit that the panel observed during the site visit.

The department's research strategy lets it produce high-quality publications and other results of worldwide relevance and visibility. The main strategy is to grow in two dimensions:

- In applied mathematics, notably in data science and PDE, through new permanent recruits
- Throughout all groups, by acquiring high-profile grants that further increase the high level of the research

However, while the strategy is convincing, its implementation is impeded on the one hand by the department's lack of proactivity in communicating and implementing its mid-term hiring strategy, and on the other hand the university's apparent lack of understanding of the needs of mathematics and small research groups. The long-term plan to continue the successful recruitment of the past, especially for replacing professors after retirement, is hampered by budgetary uncertainty and delays in obtaining university approval for the needed positions, disrupting research, teaching and management. This issue exposes the vulnerability of such small departments to turnover in their staff.

The department stands out in internationalisation at all levels and has done an excellent job in recruiting new professors to tenure or tenure-track positions, carefully taking into account gender and age balance, as per the recommendations of the last research evaluation. The department can attract excellent researchers thanks to attractive working conditions, if it is agile in international labour markets, though this also comes with a risk of those excellent academics moving on.

The department faces the challenge of chronically low undergraduate numbers in STEM. However, there are good plans in place to deal with this challenge, such as starting a very

topical and successful new study programme, continuing the department's outstanding outreach activities, and extending efforts to apply for international grants. These have already led to a remarkably steep rise in student numbers in data science. This in turn requires more teaching capacity in a department that is already under pressure and which is maintaining its high teaching standards only through the substantial involvement of PhD students and postdocs in external funding.

The department's research integrity and open science policies are consistent with international standards and appear fully appropriate.

There are several established national collaborations, including with finance, engineering and behavioural sciences at UL, as well as links to two of the three national research institutes. These could nonetheless be strengthened.

Recommendations

The panel recommends that:

- The department should be much more proactive both inside and outside the university in pursuing its hiring strategy while retaining the excellent team spirit. The university's cooperation and support are indispensable to avoid interruptions to recruitment and staffing.
- The department should strengthen the existing national collaborations and initiate new ones. The panel recommends additional support for the responsible department members, either by the modest means of teaching reductions or, more ambitiously, by funding extra staff This should also help improve the internal and external support and recognition of the department and of mathematics as a whole.
- The panel recommends the department to ensure the members of the analysis unit are well integrated into the units working on geometry, PDE, algebra and number theory.

3 Quality of Research

The department contributes substantially to the state of the art, advancing the forefront of mathematical science on the national and international level. Department members have authored several influential books which are highly cited and often serve as references in their area. Overall, the department's publications are of very high scientific quality, with some reaching the very top journals for their respective fields or mathematics overall. The research groups involve PhD students and postdocs in their research activities remarkably well. This is reflected not only in the publication record but also in the department's success in preparing junior researchers for their future careers.

The research in statistics, probability, and geometry is of outstanding international quality. More broadly, the department has many papers in level-3 journals. The listed publications are theoretical; they are excellent and internationally of the highest standard. Highlights include: the impressive work of Baraud (2021) which generalises earlier work on test and estimation strategies based on Hellinger loss to other loss functions; the innovative and original work of Nourdin et al (2019) who consider Berry's random planar wave models and their findings represent the first high-energy central limit theorem for nodal quantities associated with random Laplace eigenfunctions defined on the subset of a non-compact manifold; the award winning extensive paper of Schlenker et al (2020) which solves an important old problem of Steiner on polyhedra in real threespace whose vertices lie on a quadric; and the groundbreaking work of Parlier et al (2020) vastly generalising influential results of Mirzakhani on

simple closed geodesics on hyperbolic surfaces by making them applicable to any homeomorphism type of curve and any geometric structure of the surface.

The department has several successful interdisciplinary collaborations in sports sciences, health sciences (orthopaedic surgery), finance (via the joint appointment of a staff member with the Department of Finance), behavioural sciences, and engineering. Examples include:

1. the editorial paper of Ley et al (2022) on the opportunities of machine learning (ML) techniques for orthopaedic surgery which was highly cited;
2. Funding of interdisciplinary projects namely a FNR pride with Dept of Finance and of Engineering, a FNR Industrial fellowship with ITTM (health), a FNR INTER with Luxembourg Institute of Health and Canada and FNR Bilateral with NASA;
3. projects with the Institute for Advanced Studies with Dept of finance, Dept of Economics and Management and Dept of Behavioural and Cognitive Sciences.

During the site visit, the department set out its ambitious plans to extend their interdisciplinary, non-academic and industrial collaborations further (for example with the University of Veterinary Medicine of Vienna, ArcelorMittal, Olympic committee).

The department has been very successful in pursuing international cotutelle supervisions. However, the panel was disappointed to learn that the university's rule that co-supervisors of PhDs must be outside the university effectively forbade internal cross-disciplinary co-supervision. It was relieved to learn that this could in practice be mitigated through informal arrangements but notes that this means that faculty members providing co-supervision cannot formally receive credit for that work. This could particularly impact assistant and associate professors, as they rely on formal recognition of activities such as co-supervision for promotion and to secure funding.

The department contributes to and shapes the national and international field of mathematics via a large range of academic leadership roles in editorial boards, steering boards and organisation of international conferences. To name a few highlights, members have been or continue to be editor-of-chief (Journal of Sports Analytics, Bernoulli, SpringerBriefs in Probabilty and Mathematical Statistics, Geometricae Dedicata...) and presidents of societies (Luxembourg Statististical Society, Luxembourg Mathematical Society) and chairs of boards (CIRM scientific council, evaluation committees).

Recommendations

The panel recommends that the department and university should:

- Keep on producing high quality research and disseminating it through high calibre publications and organising international conferences while serving the community on boards and panels.
- Keep on involving junior researchers in all aspects of fundamental mathematical research.
- Approve and implement more flexible arrangements for co-supervision to support cross-disciplinary work and research careers, as opposed to effectively encouraging in-breeding in research. This may require case-by-case consideration of non-standard supervision arrangements, rather than a blanket rule.

4 Resources

4.1 Financial resources and infrastructure

The department makes excellent use of external grant funding, notably in conducting first class research. The department is very successful in acquiring funding on the national level, especially in the OPEN bottom-up research funding programme, where the department had a success rate of 67% during the evaluation period. It is less successful in the more applied FNR programmes, which are required to be consistent with the national priorities, which are not designed to support theoretical mathematical research.

On the international level, the department has been extremely successful in obtaining highly competitive Marie Skłodowska-Curie Fellowships. It also has two large-scale European grants (1 ERC CoG, 1 ERA chair), but there is still ample room to make additional applications, given the outstanding track records of several members of the department.

Thanks to recent strategic hirings, there is also a growing number of industry collaborations, which will tend to increase the department's societal impact.

The institution provides a generous amount of resources in the form of facilities and infrastructures, databases, and support services, creating an attractive research environment for its members. Most professors have a strong supply of PhD and postdoc positions and all members receive healthy support for travelling and international collaborations. This is vital, especially for the junior members, and is reflected in the department's very good track record in promoting early career researchers and preparing them for a career in mathematics (or industry).

In contrast, resources for personnel appear rather tight, and the high level of teaching, both in quality and quantity, can only be maintained thanks to the input from the external funding. To amplify this imbalance, the panel was rather surprised to hear that external funding often is indispensable to extend contracts of non-permanent researchers as planned due to untimely hurdles posed by university administration. It is these questionable issues that leave the panel wondering whether the overall funding situation is healthy.

There is no significant involvement with external infrastructure.

Recommendations

The panel recommends the department and the university to:

- Make more creative use of the funding opportunities provided by the national priorities and by the focal areas of UL, for example through doing more interdisciplinary and applied research in areas prioritised by the university, FRN and national policy. At the same time, it should take a more active role in guiding its outstanding members to apply for ERC grants while providing the necessary support and, possibly, incentives. It appears advisable to design a strategic timeline to optimise the chances of success.
- Acquire seed funding from the university to support department members involved in interdisciplinary collaborations and help lift industry collaborations to another level; this will automatically raise much more funding and thus promises to pay for itself within a short time.
- Set up a reliable and timely internal financial scheme between the department and the university which allows for successful and sustainable planning on all time scales, short term, medium term and long term.

4.2 Human resources, careers, and related policies

DMATH comprises 16 professors (12 full, 2 associate, 2 assistant). This is rather top-heavy; department research and career development would be better served by a more even balance.

The department covers a broad variety of research areas in mathematics, given its size: Algebra, Number Theory, Geometry, Topology, Probability, Stochastic analysis, Discrete and Geometric analysis, Statistics, Data analysis, PDE and Modelling. This expertise covers the areas relevant to teaching students at BSc, MSc and PhD level in mathematical sciences. The teaching load of the staff is at its maximum. The department has an impressive track record in outreach activities. It contributes to many national and international activities. The department has collaborations with public and private sectors. This latter is expected to grow by appointing more professors in statistical learning and applied mathematics. Due to the large number of full professors the average age is high. The number of female researchers has grown over the years, especially since the last research evaluation, but is still relatively low (3 professors). The staff is most international.

Succession planning is in place. However, this process starts late and takes time. This is not desirable in a field such as mathematics, where it is hard to find excellent staff due to competition with industry and other universities.

The department fosters research careers by providing a collaborative and transparent environment. Support is available for grant writing and organising workshops. Further, new staff members receive a start-up package with a PhD and/or Postdoc and reduced teaching. There is also internal funding to allocate PhD students and Post Docs to other staff members. The travel budget is generous, and international visitors are welcomed on a very regular basis.

However, the panel finds the rules about sabbaticals and parental leave to be ungenerous and family-unfriendly compared to international norms. Sabbaticals are available once per seven years but only to full professors. By law, staff on sabbatical cannot stay at the university, even if they are doing research on Luxembourg. It is problematic that department members have to cover teaching and admin tasks of colleagues who are on maternity or paternal leave, without compensation being offered to the department. Besides increasing the already high workload for staff members, this can create undue pressure – especially for women – to return to work early and to take up these tasks, to the detriment of their research.

While the department has an excellent research environment, increasing the proportion of assistant and associate professors could create a more dynamic atmosphere. Younger faculty members bring fresh perspectives, innovative ideas, and new approaches to research. Additionally, they are eligible to apply for personal grants at earlier career stages, such as the ERC Starting and Consolidator Grants, which can further enhance the department's research capabilities. To take advantage of such opportunities, and to support career development, the department needs clearer and more uniform promotion criteria and processes.

The department has a dedicated officer for gender equality and gender-related issues at the department. It also provides a member for the FSTM-wide committee on improving gender diversity in recruitment. The panel notices that both roles are assumed by female professors.

Recommendations

The panel recommends that:

- The department should consider appointing at assistant and associate level to obtain a better age balance.

- It should continue to ensure that administrative duties, including committee work, are distributed equally among male and female staff.

The university should:

- Develop and implement a uniform set of promotion criteria and requirements. This is essential for attracting excellent staff at assistant and associate level and to support career development
- Centrally support the costs of parental leave, rather than leaving the departments to find local solutions.

5 Contribution to teaching

The existing teaching programmes are excellent, having undergone some welcome development in applied mathematics (in particular, the creation a very successful new master programme). The department has also developed and increased its connections with industry and teacher training. Undergraduate and master's students benefit from a very good student/professor ratio and excellent facilities. Graduates seem to find very good jobs. Still there should be some room to create more opportunities in terms of projects and education (both within the department as well as perhaps through service activities to other departments), but this also depends on sufficient human resources.

PhD students and postdocs are well integrated in the life of the department and well supported to attend workshops and PhD training schools. Throughout, they receive attentive mentorship from their professors, as evidenced by their successful involvement in impactful research and by the career path they subsequently take.

In addition to training future mathematicians and teachers, the department also provides service teaching for other parts of the university. This is of great and increasing significance, especially given the growing importance of modelling, statistics, and the current explosion in new areas such as deep learning, quantum computing and AI, all of which require the development of a deep mathematical mindset.

While the teaching duties seem, for the moment, commensurate with the size of the department, the limits are being reached. The department's teaching capacity is vulnerable to any loss of academic staff, such as through the retirement or departure of some professor or via changes in the total amount of external funding. The panel was surprised to realise how much of the teaching capacity relies on external funding.

Recommendations

The department and the university should:

- Improve the age imbalance and increase research productivity and teaching capacity by providing the department with more temporary positions at the level of PhD students and postdocs (which would have the added benefit of making permanent positions at UL yet more attractive).
- Co-develop and share a longer-term plan for the replacement of professors.

6 Contribution to the third mission

The outreach activities of the department are outstanding and internationally recognised (e.g. World Expo Dubai 2022), though many of them depend heavily on the initiative of rather few professors, one of whom is actually leaving UL. To extend their network, members give presentations, e.g. techie Nights by Silicon Luxembourg and at conferences for healthcare professionals. The department is present at science festivals and members develop and present tailor-made activities. It has received funding for these activities (200k 2018-2024). Another example of an impressive outreach activity is the collaborative art project "The Sound of Data".

The department contributes to societal and economic development in Luxembourg via its teaching programmes. The number of students graduating has doubled. The new MSc in data science has more than 1000 applications per year, while the capacity is 60 students. The programmes offer students to do relevant industry internships, e.g. with Amazon and Goodyear.

The department has several research collaborations with industry and Luxembourg Institutes. The research in applied statistics encompasses sport sciences. On this topic there are for example collaborations within the European project Math4Sport on injury prevention in sport. During the site visit, the ongoing collaboration with orthopaedic surgery in Luxembourg was shown to be promising and growing in strength and internationality; key features include using machine learning and artificial intelligence in clinical practice and patient care.

Two members created a start-up company GrewIA. They are currently exploring opportunities to work with Luxembourg industry

Recommendations

The panel recommends the department to:

- Maintain the high volume and quality of outreach activities, but continue to spread the responsibility for driving this activity across more than one senior researcher.
- Investigate local industry and government needs, for example by organising a conference on questions on data and/or AI opportunities, to trigger more knowledge transfer to industry and society.
- Further strengthen their societal and economic impact by growing in applied mathematics and statistics via new appointments and extending collaborations with industry via joint projects.

7 Overall assessment and recommendations

The department is doing extremely well on an international scale, especially given its size. It produces research of very high quality, often extending the state of the art. This is documented by an excellent publication track record, reaching very good international publication outlets and the very top journals. It is also clear from the successful acquisition of competitive national and international grants.

The department's achievements are grounded in a rather bottom-up research strategy, largely driven at the level of individuals. Further development will require a more proactive and holistic

approach, including the timely implementation of the long-term hiring strategy developed by the department.

The university and department provide an excellent research environment, which supports the outstanding achievements of the department and the promotion of early career researchers. Much of this achievement leverages external funding acquired by the department,

The panel notes the outstanding level of outreach activities, both nationally and internationally. Societal and economic impact are on a steeply rising trajectory; the panel views this as a success story based on the department's hiring strategy over the last evaluation period (partly prompted by the previous evaluation report) - and as an incentive for further action in concert with the university leadership.

Overall recommendations

1. In cooperation with the institution, the department should improve on the implementation of the well-designed future hiring strategy, in particular with regard to succession plans. A more timely and proactive approach seems required.
2. The department should seek or allocate additional resources to develop industry collaboration and maintain the outstanding level of outreach.
3. The department should incentivise, support, and monitor ERC grant applications in order to capitalise on the great potential lying in its excellent individual researchers.
4. The department should make an effort in identifying possible ways to connect its research with the focal areas of UL and national priorities in order to create new funding opportunities, notably through FNR.
5. Overall, the department's communication with the university leadership has to be improved substantially to reduce uncertainty and avoid disruptions on the personnel level.

At the institutional level:

6. The panel invites UL to acknowledge the importance of mathematics in general and specifically the essential contribution of the department in terms of research and teaching.
7. The institution should provide reliable and stable resources for financial planning to allow for sustainable HR planning and in particular avoid disruption of all small entities. This includes compensation for staff on maternity or paternal leave; the panel especially advises the institution to encourage departments to develop timely succession plans and implement them in joint agreement without delay.
8. The panel views the sabbatical rules as impediments to the equality of all permanent professors, regardless of age, gender and family situation. The panel understands that these rules are governed by law, so it urges the institution to advocate for a more generous sabbatical policy in line with international norms, treating all professor levels alike and not penalising those with family.
9. Resolve the contradiction of largely supporting interdisciplinary centres while the rules do not allow for joint PhD student supervision across departments (or even within a unit)

technopolis group

www.technopolis-group.com