PROGRAMME EVALUATION 2025

Master's Degree in System Dynamics (Systemdynamik)
Department of Geography, University of Bergen

External Reviewer: Nici Zimmermann

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1 Background Information

1.1 The reviewer

I am Professor of System Dynamics at University College London and have extensive experience with system dynamics modelling, research and teaching, reaching back over 19 years. I am also specialising in participatory system dynamics, which is an important focus of the Bergen master programme in system dynamics. While I have never taught at a Norwegian university, I have international experience from working or studying at eight different universities in the UK, USA, Germany and Sweden.

1.2 Scope

This review focuses on the following programmes:

- Master in System Dynamics (year 1 and year 2)
- Special focus of this report: Students who study remotely or who discontinued the programme

The master's programme focuses on theories, methods, techniques, and tools of system dynamics modelling. The system dynamics programme at the University of Bergen is unique in the sense that there exists no corresponding combination of master´s and PhD education worldwide.

1.3 Method

This review is based on a review of written documents about the programmes, datasets as well as in-person meetings with students and feedback from staff. The written information includes the University of Bergen's information files about this review, the brochure about the system dynamics programme, the websites and documents on the master programme structure, student numbers and results.

In the meetings I discussed with:

- master students in year 1 and 2 who study the programme remotely or who discontinued the programme,
- a subsection of the academics.

I met each of the students separately.

During these meetings, I took notes and based this report on my meeting notes as well as the other sources mentioned above.

I asked master students about their background, study trajectory in the programme so far, their experience with it and their evaluation of the programme's teaching, structure, lecture content and staff. I also collected evaluations from academics.

2 Evaluation of the Master study programme and its courses

2.1 Students' background, awareness and motivation to join the master's programme

Students had fundamentally different academic backgrounds, ranging from mathematics, anthropology, geography, economics, public administration and else. They were attracted to the programme for different reasons and had become aware of it in diverse ways. These ways included recommendations of system dynamics made through podcasts, from people from the system dynamics field, from people outside the system dynamics field or a targeted search for a system dynamics programme via the internet.

2.2 Assessment of learning outcomes at the study programme level

Table 1 lists the master programme's learning outcomes at the study programme level. This is a sound and ambitious list of types of knowledge the students are taught, skills they learn and general competence they acquire. The learning outcomes are ambitious, e.g. because students are prepared for and expected to be able to contribute to the literature and to theory building. Thus, the programme aligns with high international standards.

Table 1: Learning outcomes

Knowledge

The candidate

- knows inherent challenges in understanding the dynamics of social systems
- knows the system dynamics paradigm and alternative methods of analysis
- knows system dynamics applications to problems in public and private sectors
- knows how system structure can be portrayed in terms of stocks, flows, and feedback
- knows behaviours that arise from fundamental structures of dynamic systems
- knows at least one system dynamics software package and is aware of others

Skills

The candidate

- is able to define problems, observe client perspectives, and assess importance
- is able to build on theory to formulate hypotheses about problem causes
- is able to build on and transfer knowledge from related cases
- is able to analyse hypotheses in terms of realism and ability to explain problems
- is able to explain behaviour, detect weaknesses, and reformulate hypotheses
- is able to evaluate the usefulness of hypotheses as theories/models for policy analysis
- is able to identify new policies and to test these by way of simulation
- is able to assess whether simulated policy options are cost-effective and practical
- is able to communication with clients to overcome hinders for implementation
- is able to report to an academic audience showing equations, diagrams, and graphs
- is able to contribute to the literature and to theory building

General competence

The candidate

- can engage in discussion with class mates, with colleagues, and with the general public
- can write and speak effectively
- can take ethical considerations into account when conducting research and interacting with clients, stakeholders, and colleagues
- can seek the roots of problems and avoid overconfidence in quick fixes
- can quickly transfer knowledge from basic models to a multitude of problem areas

2.3 Development in student numbers and completion rates

2.3.1 Figures and the programme lead's interpretation

Table 2 and Figure 1 illustrate a strong increase in the demand for the programme up to 2023, followed by a decline in 2024, while programme capacity and actual student uptake remained stable. In 2023, there was a notable rise in the number of students selecting the programme as their first priority. Academics attribute this to a combination of students not being aware that tuition fees would be introduced, as the application deadline was before the decision to implement fees, and a concerted marketing effort by academic staff to raise student numbers. In 2024, the number of students choosing the programme as their first priority fell, which academics believe reflects the true impact of the newly introduced tuition fees, with the resulting decline in applicants from outside Europe. The data highlight the local impact of a national policy change, while also demonstrating the success of staff efforts to maintain stable student intake through improved conversion rates.

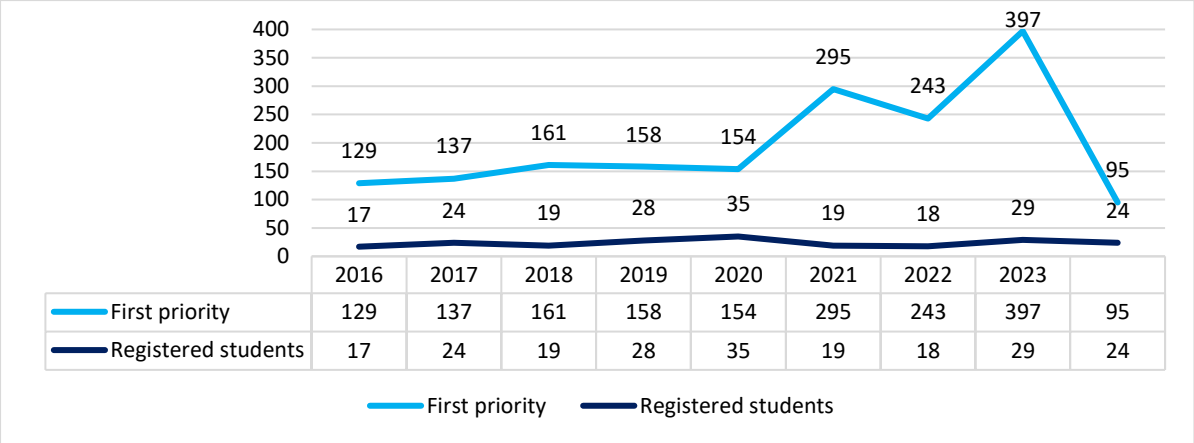

Figure 1: Demand and registrations based on demand and capacity

Table 2: Study places, applications with SD as first priority, offered study places, accepted study places and registered students (data source: Tableau)

Year	Study places	First priority	First priority applicants per study place	Offered study place	Accepted study place	Registered students	Share registered in total offered places
2016		129		36	20	17	47%
2017		137		65	34	24	37%
2018	25	161	6.4	58	28	19	33%
2019	23	158	6.9	60	33	28	47%
2020	28	154	5.5	93	70	35	38%
2021	25	295	11.8	61	37	19	30%
2022	25	243	9.7	50	19	18	36%
2023	25	397	15.9	83	50	29	35%
2024	25	95	3.8	65	34	24	37%

The table does not describe the actual situation in 2020. Due to the Covid-19 situation, 24 out of the 70 students who accept the study place accepted deferred admission until autumn 2021. This apparently left the programme with 46 student that were supposed to start in autumn 2020. 35 of them did in fact start, which is 76% of 46.

Table 3 shows throughput figures for students during the period 2014-2024.

Table 3: Registered vs. graduated students for starting years 2014-2023 (data source: Tableau)

			Semester									
Start year		Grand Total	1	2	3	4	5	6	7	8	9	10
2014	Active	18	18	15	13	13	8	4	1	2	1	1
	Accumulated graduations	9	0	1	1	3	7	9	9	9	9	9
	% graduated	50.00%	0.00%	5.56%	5.56%	16.67 %	38.89 %	50.00 %	50.00 %	50.00 %	50.00 %	50.00 %
2015	Active	35	35	29	27	26	17	9	4	4	3	2
	Accumulated graduations	20	0	0	0	7	14	18	18	19	19	20
	% graduated	57.14%	0.00%	0.00%	0.00%	20.00 %	40.00 %	51.43 %	51.43 %	54.29 %	54.29 %	57.14 %
2016	Active	18	17	14	11	10	3	3	2	1		
	Accumulated graduations	8	0	1	1	5	7	7	7	8	8	8
	% graduated	44.44%	0.00%	5.56%	5.56%	27.78 %	38.89 %	38.89 %	38.89 %	44.44 %	44.44 %	44.44 %
2017	Active	23	23	19	16	16	5	5	3	1		
	Accumulated graduations	13	0	0	0	9	9	9	11	13	13	13
	% graduated	56.52%	0.00%	0.00%	0.00%	39.13 %	39.13 %	39.13 %	47.83 %	56.52 %	56.52 %	56.52 %
2018	Active	18	18	16	13	12	2	1				
	Accumulated graduations	10	0	0	0	6	10	10	10	10	10	10
	% graduated	55.56%	0.00%	0.00%	0.00%	33.33 %	55.56 %	55.56 %	55.56 %	55.56 %	55.56 %	55.56 %
2019	Active	29	28	26	22	21	8	6	2	1	1	
	Accumulated graduations	19	0	0	0	12	13	17	18	18	19	19
	% graduated	65.52%	0.00%	0.00%	0.00%	41.38 %	44.83 %	58.62 %	62.07 %	62.07 %	65.52 %	65.52 %
2020	Active	31	31	25	20	19	10	8	2	2		
	Accumulated graduations	16	0	2	2	10	13	16	18	18	18	18
	% graduated	58.1%	0.00%	6.45%	6.45%	32.26 %	41.94 %	51.61 %	58.1%	58.1%	58.1%	58.1%
2021	Active	18	18	16	15	13	2	3	1			
	Accumulated graduations	10	0	0	0	10	10	11	12	12		
	% graduated	66.7%	0.00%	0.00%	0.00%	55.56 %	55.56 %	61.1%	66.7%	66.7%		
2022	Active	28	28	24	16	16	7	5				
	Accumulated graduations	6	0	6	6	13	14	14				
	% graduated	50.0%	0.00%	21.43 %	21.43%	46.4%	50.0%	50.0%				
2023	Active	33	32	22	18	18						
	Accumulated graduations	0	0	1	1	1						
	% graduated	3.00%	0.00%	3.00%	3.00%	3.00%						
2024	Active	27										
	Accumulated graduations	0	0	0								
	% graduated	0.00%	0.00%	0.00%								

There is, apparently a substantial discrepancy between the number of students who start and those who complete their education. In the past, a mere 44–67% of the students admitted were able to complete their studies successfully. It looks like this number might be increasing in recent years. The faculty's assessment is as follows:

The system dynamics programme is a *graduate* programme that demands that the students follow a very steep learning curve for which many students are unprepared. Most of them are unfamiliar with system dynamics because there exists no bachelor education in the discipline. The Bergen system dynamics team have opted for the admission of a wide variety of students, in terms of:

- Disciplinary background at bachelor/master level;
- Grade (min C);
- Nationality / institution of origin;
- Gender.

The rationale is to attract students from many walks of life, creating a vibrant student community that is reported to be highly appreciated by its members. Moreover, the team find it hard to predict who will be well suited for their education. They offer a web-based readiness test for the students to take on a voluntary basis, but do not offer a formal admission test. Finally, they have accepted the grade C as a minimum, the skills behind which vary significantly from institution to institution across the globe. In short, they admit a wide variety of students and thus use the studies themselves for us to assess the quality of the work the students deliver and for the students to assess their performance and suitability in the context of this program. When some students register as active students in spite of a low performance and an intent not to complete their education, that may be caused by alternative motives such as the desire to remain in Norway for part-time work. They consider this to be the reason why some students register well beyond the time when, in reality, they have terminated their full-time studies. With the study fees that came into place in 2023, the number of students who register without actively studying in the programme is expected to drop. However, this not yet visible, as the numbers show fluctuations.

2.3.2 Observations from discussions with the students on discontinuing the programme

I got the impression that students who dropped out of the programme predominantly had social science backgrounds (e.g., political science, anthropology, geography). The main reasons for considering discontinuation seemed to be that the programme differed from their expectations and did not align sufficiently with their interests.

Although the numbers are small, it appears that students who might appreciate the later semesters more than the first one tended to stay, while those for whom a system dynamics programme was generally a poorer fit chose to leave. Since these mismatches are closely tied to the architecture of the programme and courses, I will revisit this topic again in section 2.4.

2.3.3 Recommendation

I appreciate the programme's inclusive approach to admissions, welcoming students from diverse disciplinary, national and other backgrounds. Despite a historical gap between the number of students starting and finishing, the percentage of students who complete the programme has increased from about 45% to over 65% just before COVID-19 and to about 67% for the 2021 cohort.

The marketing efforts in 2023 were clearly effective, with nearly 400 students selecting the System Dynamics programme as their first priority. The drop to fewer than 100 first-priority applicants in 2024 reflects the clear impacts of the introduction of tuition fees. I recommend closely monitoring how this change affects the academic quality and diversity of the student intake.

Conversations with students who either discontinued the programme or considered doing so give the impression that the right students stayed and the right ones dropped out. This indicates that staff seem to support students well in the choices they make around their continuation in the programme.

2.4 Architecture of the study programme and courses

2.4.1 Structure and planned structural changes

The system dynamics master programme is a two-year programme of study with three semesters of taught studies and one semester of research on the master's thesis. The first year focuses strongly on the development of system dynamics skills, whereas the second year focuses more on writing skills development and the transfer of skills to the topic of natural resources and a self-chosen topic in the master thesis. Courses in the second term can be replaced by Special Topics in System Dynamics courses. There are three options focused on policy, applications and methodology.

Several changes are planned to the programme (see Table 4 and

Table 5 for a comparison of the current and new programme structure). From the academic year 2024/25, the online classes are running in person again. These changes were a core focus of my last report, and I commented very favourably.

Table 4 ***Current structure*** *and progression of the master program in System Dynamics*

Semester	Course code	Course name	ECTS	Teaching method	Assessment
1	SD302	Fundamentals of Dynamic Social Systems	10	Distance learning course / flipped classroom: Lectures, discussions and assignments	Take home exam (Corona) otherwise online proctored exam
	SD303	Model Based Analysis and Policy Design	10	Lectures, case studies, ILEs, discussions and projects	Take home exam
	SD304	System Dynamics Modeling Process	10	Lectures, computer labs, and major modeling project	Assessment of course project incl. oral presentation WITH EXTERNAL EXAMINER
2*	SD308	Policy Design and Implementation	10	Distance learning course: lectures, assignments	Assessment of modeling project that consists of a simulation model, a report and a video-recorded oral presentation WITH EXTERNAL EXAMINER
	SD321	**Model Based Socioeconomic Planning**	**10**	**Lectures, seminars and computer labs**	**Assessment of course project**
	SD325	Client-Based Modeling	10	Lectures, Seminars, computer labs	Assessment of course project incl. oral presentation WITH EXTERNAL EXAMINER
3	SD309	Model Based Interactive Learning Environments	10	Lectures and workshops	Assessment of course project incl. oral presentation

	SD310	Writing Course and Project Description	10	Lectures, seminars, and assignments	Assessment of thesis proposal incl. oral presentation
	SD330	**Natural Resource Management**	**10**	**Distance learning course: Online task, videos, animation, interactive learning environments**	**Online exam**
4	SD351	Master Thesis	30	Master thesis	Assessment of master thesis incl. oral presentation WITH EXTERNAL EXAMINER

* The following courses may substitute for a second semester course, with permission of the Department:

- GEO-SD322 Special Topics in System Dynamics, Policy (10 ECTS)
- GEO-SD323 Special Topics in System Dynamics, Applications (10 ECTS)
- GEO-SD324 Special Topics in System Dynamics, Methodology (10 ECTS)

Table 5 ***New*** *structure and progression of the master program in System Dynamics*

Semester	Course code	Course name	ECTS	Teaching method	Assessment
1	SD302	Fundamentals of System Dynamics	10	Lectures, case studies, computer labs	Take home exam
	SD303	System Dynamics Modeling and Analysis	10	Lectures, case studies, computer labs	Take home exam
	SD304	System Dynamics Modeling Process	10	Lectures, computer labs, and major modeling project	Assessment of course project incl. oral presentation
2*	SD308	Model-Based Policy Design and Analysis	10	Lectures, seminars, computer labs, and modeling project	Take home exam
	SD311	**Analytical Methods and Advanced Modeling**	**10**	**Lectures, seminars and computer labs**	**Take home exam**
	SD325	Client-Based Modeling	10	Lectures, seminars, computer labs and major modeling project	Assessment of course project incl. oral presentation
3	SD309	Model Based Interactive Learning Environments	10	Lectures, seminars, computer labs, and major project	Assessment of course project
	SD306	**Dynamic Complexity and Decision Experiments**	**10**	**Lectures, seminars, computer labs, and major project**	**Term paper**
	SD310	Writing Course and Project Description	10	Lectures, seminars, and assignments	Assessment of thesis proposal incl. oral presentation
4	SD351	Master Thesis	30	Master thesis	Assessment of master thesis incl. oral presentation WITH EXTERNAL EXAMINER

* The following courses may substitute for a second semester course, with permission of the Department:

- GEO-SD322 Special Topics in System Dynamics, Policy (10 ECTS)
- GEO-SD323 Special Topics in System Dynamics, Applications (10 ECTS)
- GEO-SD324 Special Topics in System Dynamics, Methodology (10 ECTS)
- GEO-SD330 Natural Resource Management (10 ECTS)

2.4.2 Observations from discussions with students and staff

As most students I talked to were in their first year, this section focuses on the first semester. Many still reported that the first term, particularly SD302 and SD303, was very intense. This led to a hectic semester and, for some, discouragement, making it difficult for some to stay motivated.

A number of students found the first semester too math focused, which, in their view, created a gap between those with a background in statistics or economics, who could quickly 'play around' with the concepts they learned, and those from social science disciplines. Some also felt that the first semester not applied enough or that it relied too heavily on science and economics examples, leaving out social science and humanities topics. They mentioned that the first more conceptual example, the worker burnout model, was only introduced in SD304. To better accommodate students with diverse disciplinary backgrounds and interests, they emphasised the importance of including occasional examples from the social sciences and humanities from the very beginning, rather than waiting until they have built their technical modelling skills.

There was also a suggestion to refer more continuously to systems thinking concepts and use related books, such as Dana Meadows' 'Thinking in Systems' alongside Sterman's 'Business Dynamics'. This, they believed, would help illustrate the possibilities of what can be done with system dynamics, to place the mathematical elements into a wider context and clarify their usefulness. They mentioned it would be very helpful to people who don't yet fully understand what system dynamics entails.

Concerning the placement of elements into a wider context, students also reported that they would benefit from clearer learning objectives. They wanted a high-level overview of how the courses fit together, how each lecture fits with the rest of the course, and why they are learning certain system dynamics concepts, models and model code. For example, they want more information on where they are and why, i.e. to spend more time on positioning and context before the teacher goes into details of calculations and model code.

A student also mentioned that they had expected a more research focused programme from the first semester, including qualitative analysis methods such as thematic analysis or Grounded Theory. Conversely, another student felt the programme was already too theoretical. Students appreciated opportunities to work on the topics of their interest in course 304. They also held a very positive view of staff and teaching assistants.

2.4.3 Recommendations

The architecture of the programme is excellent. The positive conversations with students reinforced that the recent changes, where implemented already, and the ideas behind them. Some tweaks could still be made. The conversations revealed that some students struggle with the strong focus on mathematical concepts during the first semester and that some find it difficult to place what they learn into a broader context. The comments suggest that students often lack the experiential knowledge to connect the concepts they learn to their potential applications. Those with a more mathematical background seem to identify potential application areas more easily than those who enter the programme without a strong mathematical foundation.

Since staff emphasise the importance of attracting students from diverse disciplinary backgrounds and admit students with a minimum grade of C, a mathematics pre-course could help create a more level playing field for all students and I recommend exploring such an option. Such a course could cover key topics from algebra and calculus. It might be possible to direct students to an existing course at the

University of Bergen or to develop a new one. Alternatively, a carefully selected online course from the vast international offerings could be an option, with a clear and strong encouragement for students to take it.

To help students better contextualise what they learn, it would also be beneficial to increase communication about how courses fit together, the learning objectives of each lecture and the purpose of individual elements. It would be useful to do this iteratively at multiple levels – programme, course, lecture and individual modelling element – ensuring that even technical mathematical formalisations are framed within a broader context. Strengthening this aspect would support expectation management and motivation by helping students recognise the value of each taught element.

To cater for a range of academic backgrounds and student interests, I also recommend integrating more social science and conceptual examples from the start, e.g. relating to people's behaviour. Iteratively revisiting 'softer' system dynamics aspects as well as system dynamics philosophy throughout the programme would also be beneficial. The modules that some students fail tend to be those of the first semester. While it is useful for students to receive early feedback on whether they have a good chance at passing the programme, not every technical element of system dynamics modelling needs to be introduced in the first semester. The new programme structure is already a great step towards creating a more unified study experience across the semesters. Introducing more systems thinking and more social science examples into the first term would further strengthen this direction.

2.5 Hybrid mode and recommendations

2.5.1 Observations from discussion with students

Students study remotely because they work in their home locations at the same time of studying the programme, sometimes on a full-time basis. They agreed that it was worthwhile and applauded the great efforts of staff and PGTAs to help them make remote study possible. How they engaged differed from live online participation to watching the videos of the lecture at a time outside of their work schedule. Depending on the course, there were about 2–3 to about 12 students participating online. Life online participation was perceived as superior to learning from class recordings, but students appreciated that the recordings gave them the opportunity to adjust the speed of the play-back and made it feasible to study at all.

Students mentioned that the live sessions and thus the recordings did not always capture all the different tools used in class. In particularly the whiteboard used in class and discussions were not captured at the beginning of the courses and there was a learning curve with every new course. Students participating life brought this to the attention of the staff, but it seemed difficult to resolve all issues on the spot and not all issues were always raised. They agreed that the programme 'can be more intentional in how it caters for online' students.

Students reported that staff were very forthcoming to online students, very approachable and supportive, e.g. PGTAs during class, and academic staff beyond the lectures. They would try to make available the material that was not recorded via other means individually to the student.

Group work differed, depending on the course, with some including life group work during class and others having a semester-long group task associated with them. One student mentioned that during live sessions the online students were often grouped together, for obvious reasons, but the student

felt these were not always the most proactive students and not the ones they would have chosen to work with.

Students expressed a wish to feel more connected with the in-person student cohort. There was mentioning of missing after-class chats and context. One student benefited a lot from a one-week visit to Bergen and another one would love to have a week of in-person teaching every three months.

Even if the remote experience cannot be what in-person participation may provide, the students fully appreciated the opportunity and said that it still created a good learning experience.

2.5.2 Recommendations

The hybrid format of the System Dynamics programme is truly unique and works well for students studying remotely. Students' consistently found the opportunity to follow the programme online extremely valuable. The hybrid delivery substantially enhances the programme's accessibility for students in Norway and abroad, allowing them to pursue a master's degree that would otherwise have been out of reach.

Students appreciated how supportive staff were. However, delivering a hybrid programme is the most challenging teaching format. Students mentioned difficulties in hearing in-class discussions and seeing what was writing on the whiteboard. To address this, I recommend investing in appropriate technology for hybrid teaching. This would improve the student experience and reduce the time staff currently spend accommodating online students when recordings do not fully not capture the lecture content. Additionally, learning to use the existing technology in the best way took time. A standardised and simple setup would help streamline this process. I suggest exploring whether a standard protocol could be implemented across all courses to ensure consistency, ease of use and reduced set-up time. Trial runs with everyone before their first lecture would also be beneficial.

Studying remotely is inherently different from attending in person. Several students wished for social connections and some in-person presence, one even joined for a week in person. To support this, it would be valuable to offer students more structured, but still not mandatory, opportunities for occasional in-person attendance. This could include an optional in-person first week, where everybody can get to know each other, as well as occasional weeks throughout the programme when in-person presence might be particularly beneficial.

Overall, I remain impressed by the programme's full hybrid mode. It is the only system dynamics programme worldwide that offers a hybrid option, rather than being entirely online or fully in-person. This makes it not only innovative within the system dynamics field but also a potential role model for other programmes.

3 Final statement

The programme has begun implementing fundamental changes to its overall architecture and these are successful. The group brings together and teaches a diverse range of system dynamics perspectives from more quantitative to more qualitative approaches, creating a well-integrated learning environment. Personnel related changes have already been implemented, and student feedback on staff has been excellent.

Overall, I am highly impressed by the system dynamics programme at the University of Bergen. The staff members have worked incredibly hard over the last years to establish and run a programme which is both outstanding and world-leading.