Programme evaluation 2024

Master's Degree in System Dynamics (Systemdynamik)

PhD in System Dynamics

Department of Geography, University of Bergen

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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 PhD 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)

The master's programme in system dynamics focuses on theories, methods, techniques, and tools aimed at addressing these needs. 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, researchers and staff. The written information include 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:

- a good number of master students,
- PhD students, and
- all current academics.

I met each of these groups 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, how they became aware of the master programme, their motivation to join it and their evaluation of the programme's teaching, structure and staff. I asked PhD students about their background and evaluation of the PhD programme. As they had typically also studied in the master programme and worked as teaching assistants, I collected their evaluations of the master programme as well. I also did so with the researchers and 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, to criminal studies and political science. Students 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, a targeted search for a system dynamics programme via the internet, o.

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 show a strong increase in the demand for the programme, yet with rather stable capacities and resulting study uptake. In 2023, we observe a strong increase in students choosing the programme and a slight increase in students who registered. The Increase in students choosing the programme as a first priority is due to a great marketing effort on the side of the academic staff to counteract the effects of study fees that were introduced in 2023.

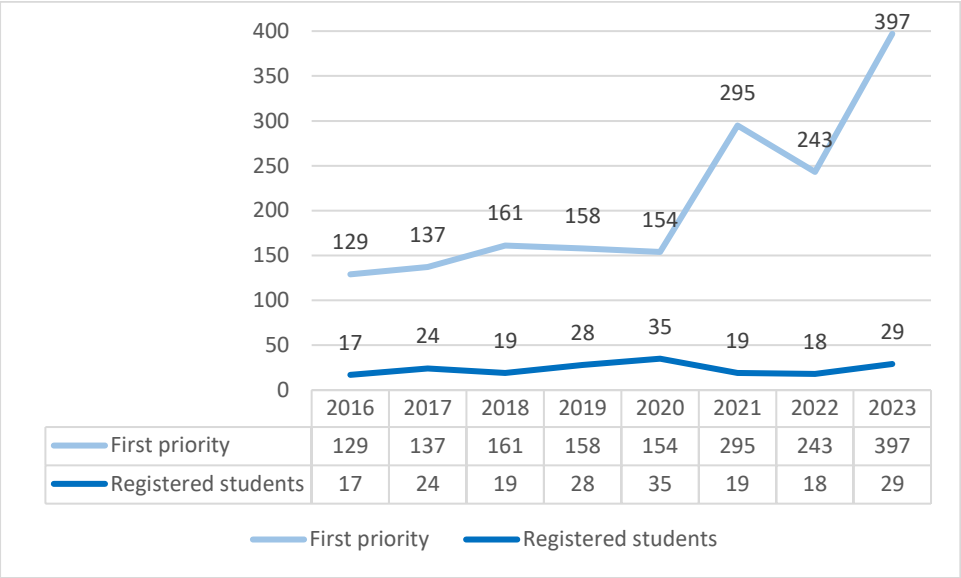

Figure 1: Demand and registrations based on demand and capacity

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%

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 2014-2023.

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	16	16		
	% graduated	51.61%	0.00%	6.45%	6.45%	32.26 %	41.94 %	51.61 %	51.61 %	51.61 %		
2021	Active	18	18	16	15	13	2	3				
	Accumulated graduations	10	0	0	0	10	10	10				
	% graduated	55.56%	0.00%	0.00%	0.00%	55.56 %	55.56 %	55.56 %				
2022	Active	28	28	24	16	16						
	Accumulated graduations	6	0	6	6	6						
	% graduated	21.43%	0.00%	21.43 %	21.43%	21.43 %						
2023	Active	33	32	22								
	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. A mere 45 – 55% of the students admitted were able to complete their studies successfully. The faculty's assessment is as follows:

The system dynamics programme is a *graduate* programme that demands that the students, most of whom are unfamiliar with system dynamics because there exists no bachelor education in the

discipline, follow a very steep learning curve for which many students are unprepared. The Bergen system dynamics team have opted for the admission of a wide variety of students, in terms of:

- Disciplinary background at bachelor / masters 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 they, in reality, 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 will be expected to drop.

2.3.2 Recommendation

I appreciate the wide and open intake of students from multiple disciplinary backgrounds, nationality and other dimensions. Despite the 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 55% for the 2021 cohort. Speaking to students who drop out will be one of the foci of my student communication and report for the next year.

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). These changes aim to focus students' skills development more strongly on the application of system dynamics skills in practice and research. The existing course SD 325 (Client-Based Modelling) will continue to increase its focus on group model building. SD321 (Model Based Socioeconomic Planning) and SD330 Natural Resource Management) will be replaced by SD311 (Analytical Methods and Advanced Modeling) and SD306 (Dynamic Complexity and Decision Experiments).

Implementing SD311 and SD306 will fulfil a dual purpose of making the best use of the new academics' expertise as well as responding to last year's request from the students to include more advanced modelling in the second year. Together with SD325, taught in the second term, the new courses will form an excellent trio of client-focused and experimental research-focused modelling. They aim at the application and transfer of system dynamics modelling skills and teach the students how to support others in their learning and decision-making through modelling.

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)

The teaching methods in the master programme are diverse. SD302, SD308 and SD330 run online, sometimes with an option to come together in class to discuss and sometimes as a full online course. It is planned to run fully online courses in person again from the academic year 2024/25. Yet, it is planned to continue making the fully online courses available to interested students.

This offers a large number of international students the opportunity to take certain courses as distance learners and the Bergen program thereby fulfils a very important role in the training of system dynamics modelers internationally. It is now also possible to study the entire programme as a distance learner, which is a remarkable possibility. In addition, the diversity of delivery methods in lectures, seminar and workshop sessions, lab sessions and group work caters for diverse learners.

2.4.2 Observations from discussions with students, researchers and staff

Overall the structure of the current programme is good, with changes on the way to make it excellent. The course structure is excellent in the first semester. Students and other groups consulted report that the first semester courses SD302, SD303 and SD304 build extremely well upon each other and this is also what I fully underline based on the written materials on the courses' content.

The structure in the second term is good. 308 builds nicely on 304 by allowing students to continue working on and extending the model they built during the first term. This continuation had been less clear to students last year, and the current situation shows that it is now communicated very clearly. Students reported they liked that it teaches them how to think about problems and how a policy might work. SD325 and the new class SD311 will allow to diversity the programme and for the students to gain rich expertise in the areas the staff are well known in: sound quantitative system dynamics, the interlinkages with other types of modelling and participatory modelling.

The proposed structure of the third term now also looks great. Course SD330 on natural resource management had been the course that fitted in least. It will be replaced by what seems to be an innovative research-focused course that very intelligently brings in new diversification while offering the potential to generate interesting data for publications. This could offer the students the opportunity to publish interesting papers in collaboration with the teaching academics, e.g. via deeper analysis of the material in master theses. Last year, students had reported that they wished a greater system dynamics focus in the third year. Now, with two of the three courses of the third term focusing on system dynamics learning environments and decision experiments, this will be achieved.

Currently, the third semester course SD310 (Writing Course and Project Description) covers 10 ECTS and staff mentioned potential plans to reduce it to 5 ECTS.

Some students reported they still needed to find their feet during the first course and everybody reported that they learned a lot. While some reported to appreciate that the second course was hands on, others did not fully recognise how much they learn through hands-on activities.

Students expressed a wish for even further alignment between the courses in terms of the course syllabi containing the same type of information. They also expressed that there had been some issues with teaching assistants in the beginning so that the lectures and tutorials were not fully aligned. This seems to have been picked up during the course of the semester already and students reported that TA support was great during the second half of the semester. Students' valued the weekly feedback they received from TAs. They also valued that somebody asked what was going on when their grades for weekly assignments dropped.

Students reported that the small overlap, which staff had purposely designed at the beginning of the courses, was an opportunity to catch up but also felt like a redundant repetition. They reported to prefer having a break to having a recap.

The new course structure does not include fully online courses for students studying on campus anymore, but already now the programme runs in a fully hybrid mode.

There was a mixed response to the use of different SD modelling software in the courses, Stella and Insight Maker. Some appreciated that a different software taught them a lot more about modelling, whereas others perceived the switch from Stella to Insight Maker as a reduction and suggested to start with learning the bones of modelling in Insight Maker and then switching to the more advanced software Stella. Students also expressed a wish to do participatory modelling with a software focused on group modelling.

Overall, the programme was assessed very positively by the students. First-year students had just finished an intensive week of hands-on negotiations for SD308 and found this an excellent learning experience. Students were very positive about the strongly interactive nature of their programme. They valued to 'not just sit and listen', to include elements of participatory modelling, and to get to know the research of the PhD students. They also thought the diverse backgrounds of their peers strongly enriched the experience because it allowed them to look beyond their own discipline.

2.4.3 Recommendations

The programme with its suggested changes is excellent and recommendations are minor. Last year's recommendations have been included in the new course structure with better communication of the link between SD304 and SD308, a higher focus on participatory modelling in existing courses, inclusion of more advanced system dynamics in later semesters and replacement of some less relevant courses.

With these changes implemented, the focus on natural resources and sustainability has been reduced. I recommend paying close attention to how this shift from a topic focus to a greater modelling specialisation focus is perceived by the students and to consider how sustainability concepts can still be incorporated in the programme. At the same time, it would be useful to monitor how the new structure helps students apply their skills in practice.

Slight improvements can be made through better communication and expectation management around the very valuable hands-on learning approach of SD303. It would help some students recognise the value from the beginning if they were told more directly why they will learn through hands-on exercises and modelling and how much they will gain through such activities.

The ECTS load of the course SD310 remains an open question. This includes considering whether 5 ECTS of this current course could be replaced to make further space to enhance students' knowledge e.g. of quantitative modelling methods beyond system dynamics such as agent-based modelling, machine learning, etc., as well as qualitative soft operations research methods such as problem structuring methods, soft systems methodology, critical systems thinking, or else. This will help students work across boundaries with other modellers and disciplines and make good methodological choices. Introducing further methodological knowledge would be a wonderful gain, but I recommend carefully considering the extent to which other methods are introduced, ensuring the programme maintains its clear focus on system dynamics. This approach will preserve the depth of knowledge that students currently gain.

Concerning software, there is no clear recommendation because any solution will have different benefits and disbenefits. It is just a topic which I recommend to monitor further.

In the new programme structure, there is a clear alignment with the staff members' core expertise. It would be beneficial to implement the already existing idea to equally streamline and align dissertation topics with the specialisation areas and staff members' core expertise. Deviations from this could still be possible, but it would enhance staff wellbeing if this is a rare case rather than the normal situation.

2.5 Workload

2.5.1 Student perception

The overall workload was perceived as intense again by first-year students, potentially somewhat less than by last year's cohort. They found SD302 exactly adequate, SD303 and SD304 as more intense, and reported to feel more exhausted as the semester progressed. They found it challenging that the

7-week terms merge seamlessly into one another, with a final submission for one block on a Friday and a new block starting directly on the Monday. They also found it difficult to work continuously on modelling projects with a new assignment being launched right at the submission deadline of the previous one.

2.5.2 Recommendation

The most obvious workload-related recommendation relates to the recap of previously learned material that new courses start with. A short break to give the students at least a long weekend of 4+ days between courses would potentially help them get better through the first semester. A similar policy could be considered within courses with a one-day break between an assignment submission and launch of the next one.

2.6 Assessment methods and recommendations

Assignments are fully adequate. They are linked well do the module content in the initial courses. The students found the feedback to their assignments very useful.

Assessments could be different for these two groups, with a requirement for incoming students to focus less on modelling or on simpler forms of modelling only and with a requirement for advanced system dynamics students to apply these advanced skills and integrate them well with the subject content. Alternatively, the uniform assignment could be kept, but it would then be important to have balanced groups, to assign different tasks to different group members and to assess student performance more directly on their contribution rather than a uniform group report.

2.7 Hybrid mode and recommendations

Students' consistently perceived having the opportunity to follow the programme or certain lectures online as a valuable surplus. Different students' evaluation of the online experience differed, with some evaluating it as purely positive and others perceiving the online experience as inferior to the in-person experience. The option to join the programme and classes from online allowed them to continue studying when they needed or wanted to be with family, for example. They reported that improvements could be made to the experience of students joining online, but are aware that changes are difficult to implement as long as students have the right to object to being recorded. For example, students recommended having cameras pointed at the students to make online participants feel as part of the group. They also recommended using a digital whiteboard rather than a board that is filmed. They liked to have mixed groups of in-person and remote students rather than forming groups just within these two groups. They also appreciated how reactive staff were to their suggestions so far.

The hybrid offer of the System Dynamics programme is truly unique. To enhance online participants' experience, it would be useful to investigate benefits and disbenefits of also pointing cameras to the students. I recommend considering a stronger use of tablets for modelling rather than whiteboards. It might also be worthwhile to investigate which software allows a good user experience, but it is clear that some limitations for online participants will remain because it will still be important to also teach modelling with pens and paper on a board.

The programme seems to work very well for first-year distance students who feel integrated. They reported to have much contact among each other, but also to the in-person students via joint projects. Reports from the faculty members and from second-year students were somewhat mixed on the topic. There was no second year distance learner present in the meetings, but it was reported that it had been challenging to fully integrate for those not on campus. As this problem did not seem present this year, corrective measures might already work very well. But this will be a theme I will continue to explore also next year in order not to rely too much on the perspectives of just very few students.

Overall, I was impressed by the fully hybrid mode of the programme. It is the only system dynamics programme worldwide that offers a hybrid option, rather than being a fully online or a full in-person programme, and it may be an innovative role model for non-system dynamics programmes as well.

2.8 Community

Students feel that they are part of a community. A lot of faculty effort goes into building a community and the results of this effort are evident. Students found the three core academics to be 'beyond expectations'. They reported repeatedly their appreciation for them and for how responsively they reacted to any student requests.

3 Exchange with others

There is a monthly research seminar where members of the SD group take turns in presenting and discussing their work. This seminar series also includes presentations by external people. It may be a new series because it was reported last year that no seminar explicitly focused on system dynamics existed. I recommend keeping this up to continue developing strong bonds between students, researchers and academics as well as visitors.

4 Final statement

The programme is in the process of undergoing a fundamental change form a personnel perspective and concerning the architecture of the programme. The personnel related changes have already been implemented with two former professors being retired and replaced by two new professors. The group covers a diversity of system dynamics foci from more quantitative to more qualitative approaches, which integrates well. Changes to the programme itself are imminent and will be implemented in the 2024/25 academic year.

Overall, I am very impressed by the system dynamics programmes at the University of Bergen. The staff members have worked very hard over the last years to put in place a programme which is outstanding and world-leading.

Next year's report will include a greater focus on remote students as well as students who discontinue the programme. It will also be interesting to investigate the students' reactions to the planned programme changes.