Programme evaluation

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 Associate Professor in System dynamics at University College London. I have extensive experience with system dynamics modelling, research and teaching, reaching back over 18 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 at 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)
- PhD in System Dynamics

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 exist 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 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 small number of first-year master students,
- a very good number of second-year master students,
- almost all PhD students,
- all researchers and
- all current academics.

I met each of these groups separately.

These meetings were recorded and I based this report on my meeting notes as well as the recordings of the different meetings plus the other sources mentioned above.

I have asked master students how they became aware of the master programme, their background and their evaluation of the programme. 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 Awareness

Students were attracted to the programme for different reasons and had become aware of it in diverse ways. These ways included direct recommendations from people from the system dynamics field, from people outside the system dynamics field, a targeted search for a system dynamics programme via the System Dynamics Society website as well as broader searches for analytical or sustainability-related master programmes in general.

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.

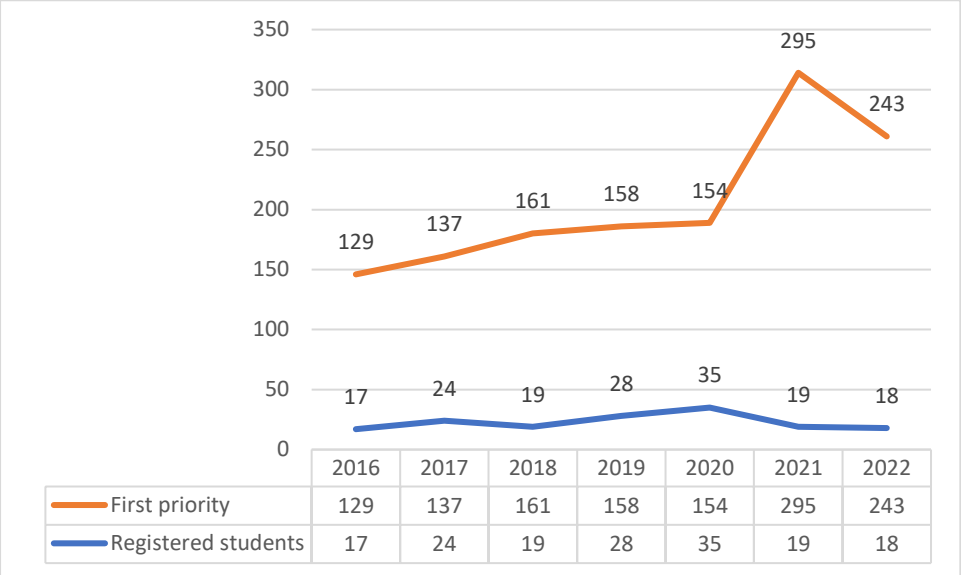

Figure 1: Demand and registrations based on demand and capacity

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%

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 2014-2020.

Table 3: Registered vs. graduated students for starting years 2014-2018 (data source: Tableau)

			Semester number							
Start year		Grand Total	1	2	3	4	5	6	7	8

2014	Active	18	18	15	13	13	8	4	1	2
	Accumulated graduations	8	0	1	1	3	6	8	8	8
	% graduated	44.44%	0.00%	5.56%	5.56%	16.67%	33.33%	44.44%	44.44%	44.44%
2015	Active	35	35	29	27	26	17	9	4	4
	Accumulated graduations	19	0	0	0	7	14	18	18	19
	% graduated	54.29%	0.00%	0.00%	0.00%	20.00%	40.00%	51.43%	51.43%	54.29%
2016	Active	18	17	14	11	10	3	3	2	1
	Accumulated graduations	8	0	1	1	5	7	7	7	8
	% graduated	44.44%	0.00%	5.56%	5.56%	27.78%	38.89%	38.89%	38.89%	44.44%
2017	Active	23	23	19	16	16	5	5	3	
	Accumulated graduations	11	0	0	0	9	9	11	11	11
	% graduated	47.83%	0.00%	0.00%	0.00%	39.13%	39.13%	47.83%		
2018	Active	18	18	16	13	12	2	1		
	Accumulated graduations	10	0	0	0	10	10	10	10	10
	% graduated	55.56%	0.00%	0.00%	0.00%	33.33%	55.56%	58.62%	58.62%	
2019	Active	29	28	26	22	21	8	6	2	
	Accumulated graduations	17				12	13	17	17	
	% graduated	58.62%				41.38%	44.83%	58.62%	58.62%	
2020	Active	31	31	25	20	19	10			
	Accumulated graduations	10	0	2	2	10	10	10	10	
	% graduated	32.26%	0%	6.45%	6.45%	32.26%	32.26%			
2021	Active	18	18	16	15					
	Accumulated graduations	0%								
	% graduated									
2022	Active	28	28							
	Accumulated graduations	0%								
	% graduated									

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 that they want students from many walks of life, which makes up a vibrant student community that is reported to be highly appreciated by the students. 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.

2.3.2 Recommendation

I appreciate the wide and open intake of students from multiple disciplinary backgrounds, nationality and other dimensions. This will be even more important with the upcoming introduction of fees for international students in Norway.

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 55%. I have not had the chance to speak to students who drop out and will make this a focus on my next year's report.

2.4 Architecture of the study programme and courses

2.4.1 Structure

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.

Table 4: Structure and progression of the master program in System Dynamics

Semester	Semester focus	Course code	Course name	ECST	Teaching method	Assessment
1*	Methodology – building blocks Individual work	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
2**	Applications Group work	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

		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
3	Methodology – specialisation and dissemination Group and individual work	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	Master thesis Individual work	SD351	Master Thesis	30	Master thesis	Assessment of master thesis incl. oral presentation

* non-master program courses in the first semester

- GEO-SD322 to comply with our obligations in the SIU/DIKU Ukraine exchange program.
- GEO-SD323 to comply with our obligations in the SIU/DIKU North Dakota exchange program.

** 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. 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 programme is good, but some modifications can be made. The structure of the programme is excellent in the first semester. Students and other groups consulted report that the 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. Students reported on the intensity of the programme, particularly in the beginning and particularly in course SD303.

The structure in the second term is good as well, but the linkages between the different courses are less clear to some of the students, while being clearer to others. Some liked that they start a project in their third course SD304, which they then continue working on in their fourth course SD308, when

adding a policy perspective to it. The focus on policy in the second-semester course SD308 is very useful and while some students saw a clear link to the course 304, this link was not perceived by all students.

Second year students reported quite unanimously that they learned much during the first year of study but less during the second year. This was also raised in the meetings with the other groups. They observe that this may be partially because of the intensity of the programme in the first year though, yet students wanted a greater focus on system dynamics modelling in the third semester.

The writing course SD310 was considered important by academics but some students did not perceive as strong learning from this course as in the very intense system dynamics courses of year 1.

Course SD330 on natural resource management is probably the course that is least connected to the others. Opinions were mixed with some considering it somewhat out of scope and others commending it. At the same time if offers opportunities. Academics and researchers expressed a wish to slightly restructure the programme and add a limited number of special foci, which are closely aligned with the core academics' competencies. Academics also expressed a wish to end fully online courses for students studying on campus and to include more in-person activities in addition to online components.

Students expressed that in some groupwork activities, those who study the full system dynamics programme and are already more advanced in modelling are teamed up with students who may just join one class. This may create difficulties if teams have too many members with no system dynamics experience.

Overall, the programme was assessed very positively by the students. They commended the amount of system dynamics modelling they learn, the fact that the programme was (still) for free, which allowed them to engage in studies and which they would otherwise not always have had the opportunity to do. They also particularly commended the strong engagement from the three faculty members to support them through their learning journey and as members of a system dynamics community.

2.4.3 Recommendations

I advise to make connections between courses as clear as possible. What is a clear logical sequence may not appear as a logical sequence for some students when each course is taught in a different manner by different members of the system dynamics group. For example, there is a chance to make the link between the courses SD304 and SD308 clearer, e.g. by asking students to continue working on the models they created in SD304 and adding policy structure to it in SD308. This can be done in addition to adding policy structure to other models.

As the first term and particularly the course SD303 are the most intense ones, it would be useful to consider the opportunity to extend the duration of the SD303 course or to transfer some of its content to other courses. However, it will need to be considered how this will affect incoming students who do not study the entire 2-year programme.

I consider the course SD310 on writing scientifically relevant. While it leads to a dissertation proposal, its importance for the dissertation needs to be made even clearer to students so that it is perceived by everyone as an opportunity to develop the necessary writing skills needed and make sound choices for their dissertations early.

I also recommend including modelling into the courses during the third semester. Specialised content courses could be added to allow the students to chose a focus based on their interests and the academics' expertise. As the University of Bergen is also catering for a lot of incoming students who do not have system dynamics experience, it will be important to address this. Content-focused elements can be taught jointly, but the teaching for system dynamics elements could be split into a beginners' and an advanced group, so that system dynamics students continue to learn advanced system dynamics modelling while learning specific content and how they can link modelling to this content.

SD330 stands out from the programme because it is focused on subject matter (environmental resource management) rather than on modelling. In light of the changing job landscape as well as in light of the manageability of the entire system dynamics programme with only three staff members, I recommend considering to introduce certain specialisation tracks through the specialised content courses mentioned above, where students select a topic focus, while continuing to learn advanced modelling relevant to such a content focus. Here, it is possible to align the specialisations with the research areas of the staff members, which ensures the students are taught the most innovative content.

Dissertation topics could be streamlined and aligned 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.

The system dynamics group in Bergen is known internationally as one of the research hubs for participatory modelling. While there are some more informal training possibilities offered to students, I recommend considering how participatory modelling can become one of the core elements taught in the programme. This might be at introductory level for all students and as a specialisation track for those deeply interested in the topic.

2.5 Workload

2.5.1 Student perception

The workload was perceived high by first-year students. One student mentioned the amount to be 'a shock'. Nevertheless, also this student is very satisfied with the programme overall. First-year students reported that they are learning a lot and highly appreciate this. Second year students do so as well. They reported that the workload decreases in the second year. I have addressed this in section 2.4 already.

2.5.2 Recommendation

In section 2.4 I already recommended some changes to the courses, e.g. to easy SD303 somewhat and to strengthen the advanced modelling component in the third semester because students seem to have the capacity to take on somewhat more during that term.

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 multiple short quizzes in the very first module were useful. A number of students

found it difficult to deal with the rather large differences in skill in the second year, when students with advanced system dynamics knowledge and visiting students without systems knowledge are grouped together.

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 Distance students and recommendations

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, also students studying at a distance. They appreciated the individual meeting that distance students had with Birgit Kopainsky at the start of the programme. A lot of faculty effort goes into building a community and the results of this effort are evident.

3 Evaluation of the PhD programme

3.1 Courses and related recommendations

PhD students are required to take 30 credits, i.e. an equivalent of one semester of full-time study. They reported that most students take more than the required amount of courses. I consider this a very good practice because courses that students take based on self-motivation are certainly valued higher by them than courses they need to take to fill a credit target. They reported that the offer of PhD-level courses at the University of Bergen is low, which requires them to take many of these courses at other universities. While they reported having a healthy travel budget, they wish for more courses being offered at the University of Bergen.

While I envision that it would be difficult for the existing three staff members to add an offer of PhD courses, an exchange with other system dynamics focused institutions is highly recommended. For this, please also see section 4.2.

3.2 Learning opportunities and related recommendations

PhD students also expressed a general desire to improve their methodological skills. While there exist courses for general methodological skills such as qualitative research or statistics at other universities that the PhD students have access to, their was a great desire to learn more about system dynamics and in particular participatory system dynamics, because many of the students apply these in their PhD projects. The before-mentioned participatory system dynamics training can be one route into this. At the same time, it would offer PhD students a learning opportunity from being a teaching assistant. Beyond this, continuing to involve the students also in the participatory projects that do not directly relate to their PhD work is a good way to ensure that learning opportunities are present.

One further point raised by PhD students is the need to collect a certain number of credits during their PhD studies. While this was perceived as easy by students who were part of a research project and who could get credit for tasks by which they contributed to this project, it was a stronger challenge for other students. Teaching assistant opportunities were limited.

As one way to create synergies also with the high demands posed on staff members, I recommend exploring a greater involvement of PhD students (and potentially also researchers) in teaching. Responsibility for certain tasks, such as a half-lecture on a topic that they know deeply from their research, could grow their skills, make them more employable and over time provide a relief to the permanent staff members.

3.3 Community and related recommendations

The community between PhD students is very strong. They have formed excellent informal bonds; many meet daily for lunch and those who are affiliated with another faculty also meet the rest of the group on a weekly basis.

PhD students articulated the wish that the time they spend on informal feedback to each other be formally recognised. One the one hand, this could help with the issue that some students have difficulty filling the required time they are supposed to work for the university and this time could then be recognised. On the other hand, it may affect intrinsic motivation and I recommend to be somewhat careful here to not destroy intrinsic motivations to help by a too formalised structure. But students said that even inf there is no formal accounting of the hours, at least some more recognition would be valuable.

4 Further recommendations

4.1 System dynamics group seminar

While there are regular seminars in the Institute of Geography, there is no seminar specifically within the system dynamics group and on system dynamics topics. To further enhance the community, I recommend initiating an informal seminar. It offers opportunity to further strengthen the already good links among master and PhD students, researchers and staff, I recommend the introduction of a ‘seminar and social’ activity, that allows to bring everybody together on a monthly or quarterly basis to learn and exchange.

4.2 Exchange with other system dynamics groups

PhD students in particular expressed the wish for a greater exchange with other like-minded system dynamics groups at other universities. I very much recommend exploring such opportunities. With COVID-19 becoming normalised, there are possibilities to take up a joint offer again across a group of European universities that teach system dynamics or to reach out beyond Europe, e.g. via a newly introduced System Dynamics Group Seminar series that invites international speakers.

5 Final statement

The answers I received from different groups were rather consistent. The largest difference might have been between first- and second-year students with regards to distance learning. This might be the result of changes that have already been implemented. It was also possible to see a great overlap between the reports from academics and researchers, indicating a strong involvement and overview perspective of researchers.

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 can be tweaked in some areas but is already outstanding and world-leading.