AL2115

Transdisciplinary Approaches for System Innovations

VT17

Course evaluation report

Description of the course

In 2017 the course ***AL2115 Transdisciplinary Approaches for System Innovations*** has been conducted for the first time. The course aims at providing students with insights on socio-technical processes in system innovations and equipping them with participatory methods to facilitate sustainability transitions of socio-technical systems.
The course includes three thematic blocks:

- Theme 1. System innovations: Multi-level perspective (MLP)
- Theme 2. Transdisciplinarity: Actor analysis and participatory methods
- Theme 3. Methods for facilitation of sustainable transitions: Participatory backcasting

This year the course included 8 lectures, 28 seminars, two individual assignments, and one project work assignment performed in groups. The course started with an introductory lecture on January 17th and ended with the Final presentation of the group projects on March 10th.

The course included two **Home assignments** (HA). The **HA1** was focused on the MLP and its application to the case of the electric cars development in the USA during the 20th century. To complete the HA1 the students watched the documentary 'Who Killed the Electric Car?" and reflected on the electric vehicle innovation pathway outlined in the documentary in terms of niche, regime and landscape dynamics, as well as analysed the barriers that the electric vehicle niche faced. The **HA2** was connected to the actor analysis and interviews within the project work. The students have to analyse a given stakeholder group in terms of their power and interest and then develop five questions to interview a representative of the analysed stakeholder group.

This year the ***Project work*** was aimed at designing a desirable future vision for **KTH Campus−2050** and developing a pathway on how to reach this vision. Through the project work students have learned and applied 13 steps of the participatory backcasting (PB) framework. The project work ***deliverables*** included: (1) Group interim presentation / Critique session; (2) Group final presentation; (3) Group report; (4) Individual reflections.

In order to facilitate the project work and stimulate the creativity of the students, the course activities have taken place in ***various locations at the KTH campus*** (e.g. Reaktorhallen, Dome of Visions, OpenLab) and included the ***Tour around the campus*** organised in collaboration with the Smart Spaces research group / Department of Architecture and the Department of Media Technology and Interaction Design. During the tour the students had the opportunity to attend the presentations of representatives of Akademiska Hus and KTH Sustainability Office, who shared their experiences with the students and answered their questions during the discussion. Later in the course, the project groups also have ***interviewed*** representatives of these organisations, as well as other stakeholders in KTH campus (mainly researchers, teachers, and students from different departments).

During the course a number of novel for the engineering education pedagogical techniques have been applied. One of them is ***Critique*** which was implemented during the Interim and Final presentations. Critique is a technique widely applied in the architecture education.

Critique sessions facilitated reflections on teamwork process and learning, quality of reasoning and decision-making process, as well as quality of overall presentation (communicative skills, presentation form, content, response to feedback etc.).

In order to visualize and communicate the final results of the project work three (of four) groups have created the movies and posters and the fourth group made a podcast and posters. The ***Final presentations*** have been organised in the Dome of Visions and was attended by representatives of the stakeholders involved in the course (Akademiska Hus, researchers and students from different departments).

The course was designed and implemented by:

- *Olga Kordas* - coordination of the course, course design, lecturing (Theme 1, Theme 3);
- *Kateryna Pereverza* - course design, lecturing (Themes 2 and Theme 3), coordination of the Project work, supervision of the groups during all seminars;
- *Aina Bruno* - supervisors of the groups during all seminars, course administration and communication;
- *Charlie Gullström Hughes* - course design, facilitation of the Critiques sessions, organisation of the Tour around KTH campus, involvement of the relevant stakeholders;
- *Oleksiy Pasichnyi* - course design, supervision of the groups during several seminars;
- *David Lazarevic* - contribution to the course design, lecturing (Theme 1);
- *Leif Handberg* - contribution to the course design, organisation of the Tour around KTH campus;
- *Jean-Baptiste Thomas* – the lecture about interview design and implementation (Theme 2).

Students of the course in 2017

The course have been attended by **16 students** (initially 17, one has dropped off due to unknown reasons).

The students come from two master programs: **10** students from KIC InnoEnergy master program ***Energy for Smart Cities*** and **6** from ***Sustainable Technology*** master program.

The distribution by genders was the following: **7 female** and **9 male** students.

Among the course students the majority had **international** bachelor education - **13** (from Bangladesh, China, India, Italy, Portugal, and Spain) and **3** with **Swedish** bachelor degrees.

The Fig.1 depicts the main features of the students that have participated in the course.

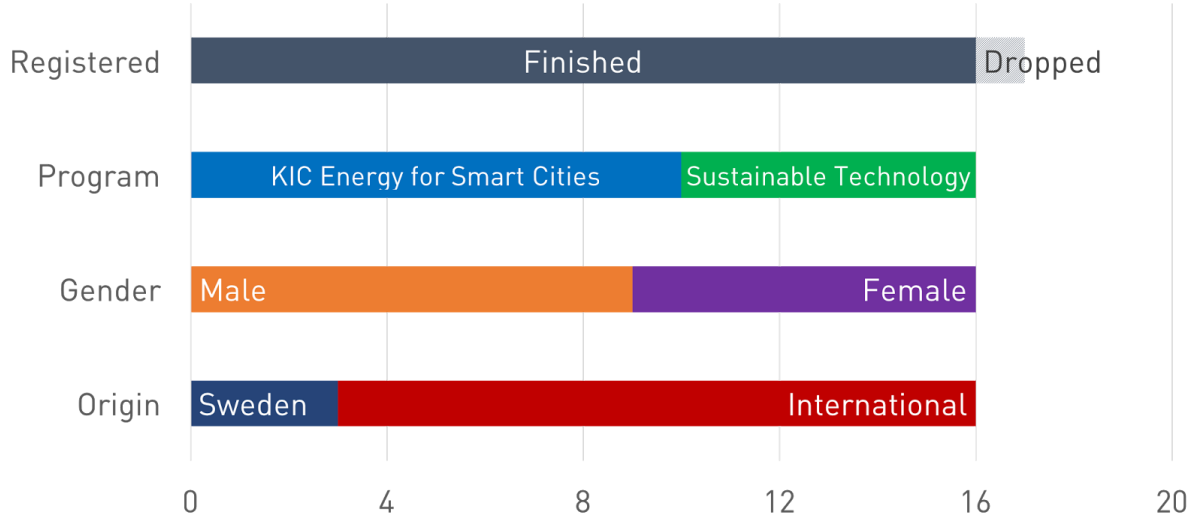


Figure 1. Features of the students that have participated in the course AL2115 VT17.

Administration and communication platform

The administration of the course and communication with the students have been performed through the platform **Canvas**, which has been piloted at KTH during VT17.

Canvas is a rather good platform for the course administration – it allows to easily publish information in various formats, create pages, insert links and upload files. Canvas provides tools for plagiarism check (URKUND) and includes rather well functioning SpeedGrader for grading and commenting assignments.

At the same time, there were a number of complications related to performance and stability of Canvas. Sometimes functioning of the platform have been interrupted causing difficulties in communication with students. Also, support from Canvas administrators at KTH with implementation of URKUND as well as of some other features of the platform was sometimes delayed. The peer-review process implemented in Canvas worked rather well, however it required very clear guidelines for students in order to make the results of peer-reviewing available for evaluation both by teachers and students. Moreover, Canvas does not allow the use of the peer-review tool when assignments are configured as "group-assignments".

Course evaluation

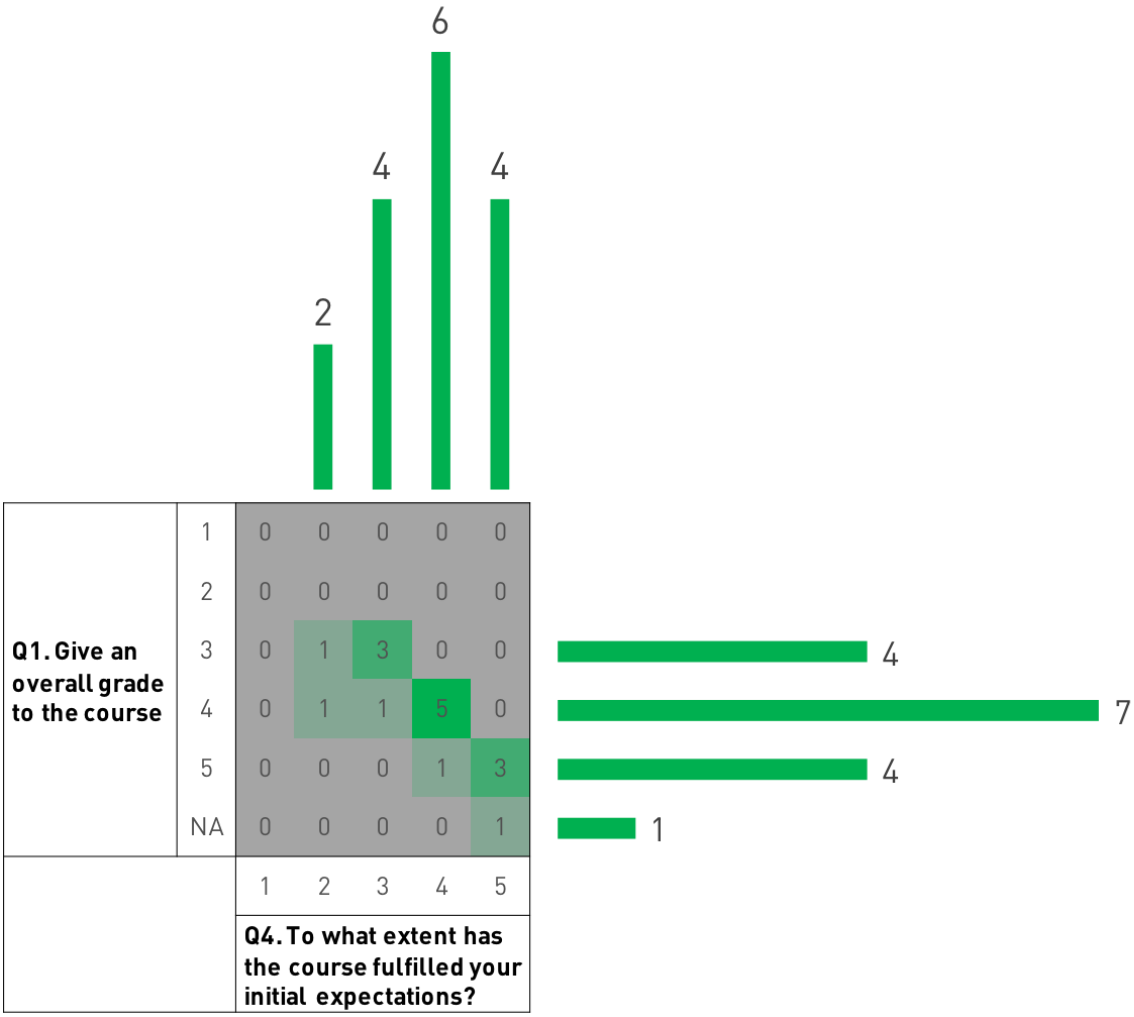
The course evaluation is based on the data collected through the following means:

- Questionnaire to evaluate the initial knowledge and skills of the students related to the course topics (filled in by the students during the Introductory lecture).
- Interim meeting with the reference group in order to assess the progress of the course (5 representatives of the course students).

- Course evaluation questionnaire (filled in during the last seminar).
- Skills evaluation questionnaire (filled in during the Final presentation).
- Final meeting with reference group after submission of group reports
  (3 representatives of the course students).

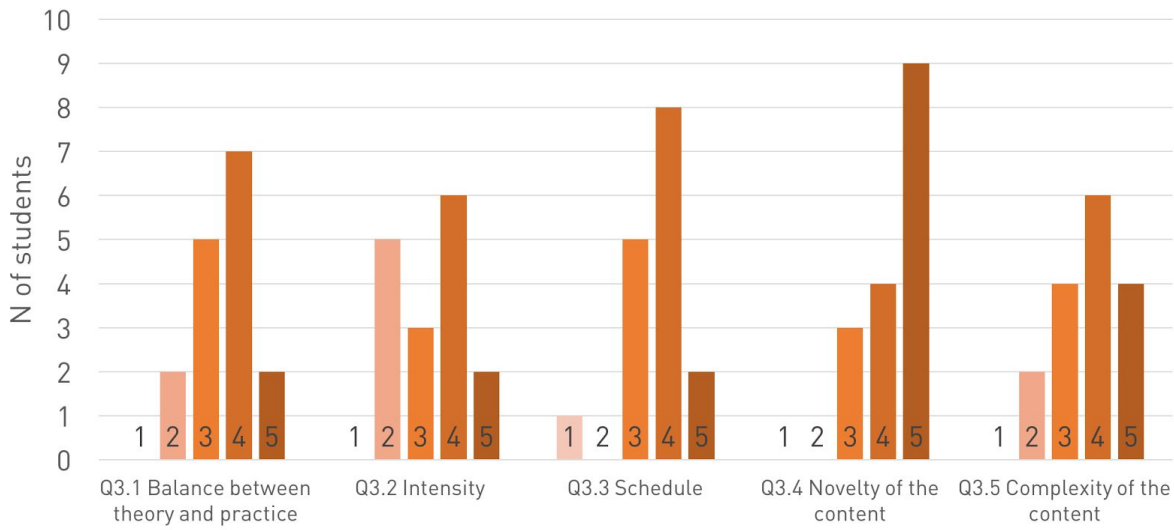
Overall course evaluation

The following figure shows the correlation between overall grades and of how well the course has met the initial expectations of the students. The dependence is almost linear.



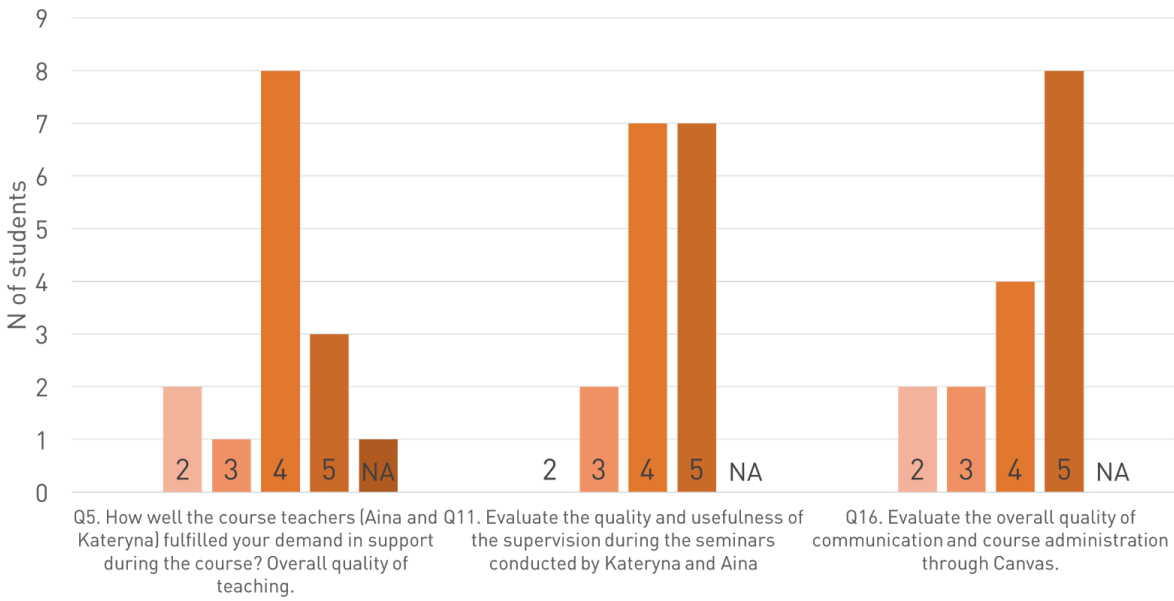
Evaluation by criteria

The following figure shows the outcomes of the course evaluation by five criteria:
(1) Balance between theory and practice; (2) Intensity; (3) Schedule; (4) Novelty of the content; (5) Complexity of the content.



Teaching and supervision

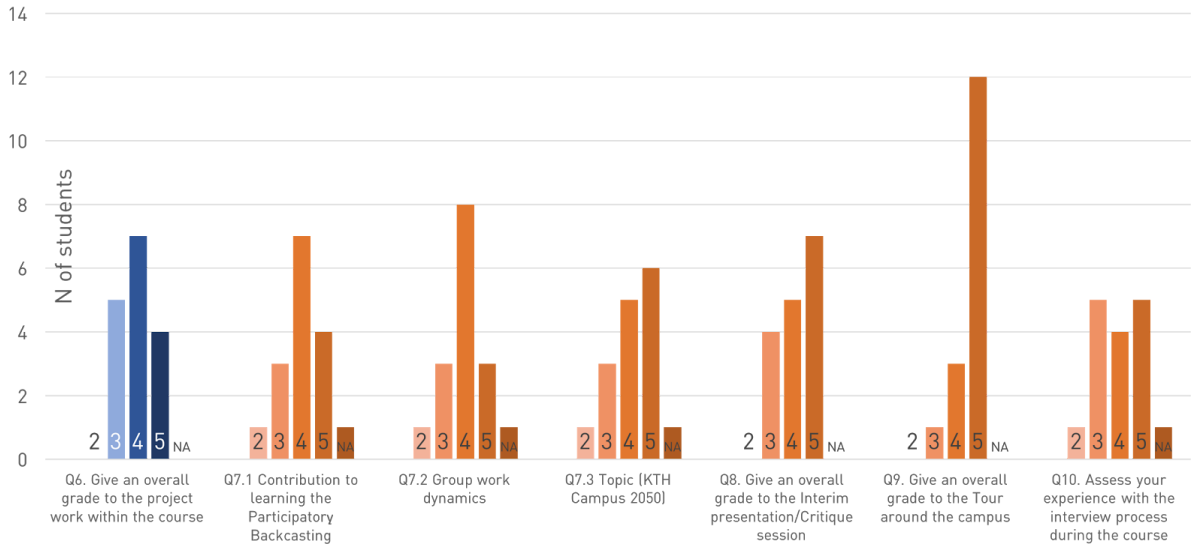
The teaching and supervision have been evaluated through two different questions - the fisrt one was related to the overall quality of teaching during the course and the second one was related to the quality of group supervision during the Project work seminars. The third question is related to the quality of the course administration and communication through Canvas.



Project work evaluation

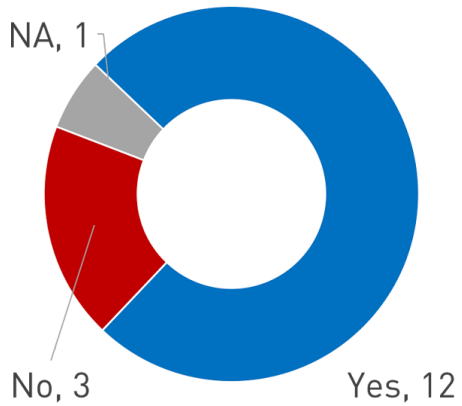
Project work was evaluated overall and by 3 sub criteria, namely: (1) Contribution to learning of PB; (2) Group dynamics; (3) Topic. Another three questions within the Project work evaluation section concern different parts of the project work – Interim presentation

(performed in a form of critique session), Tour around KTH campus, and interview process with stakeholders of KTH campus.

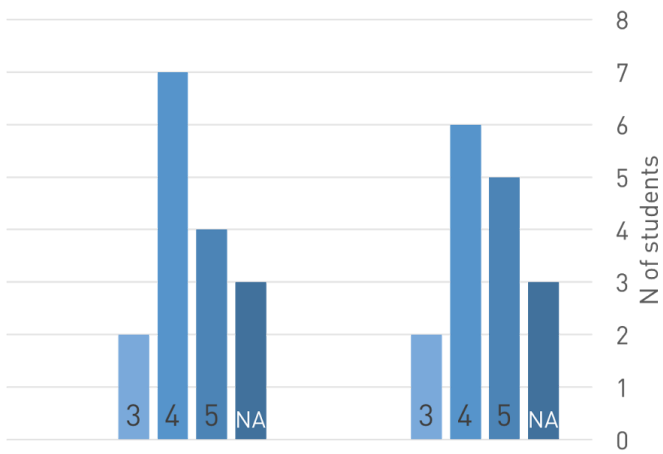


Literature

Each lecture, seminar and home assignment within the course were connected to the relevant literature provided to students through Canvas.



Q13 Have you read the course literature?



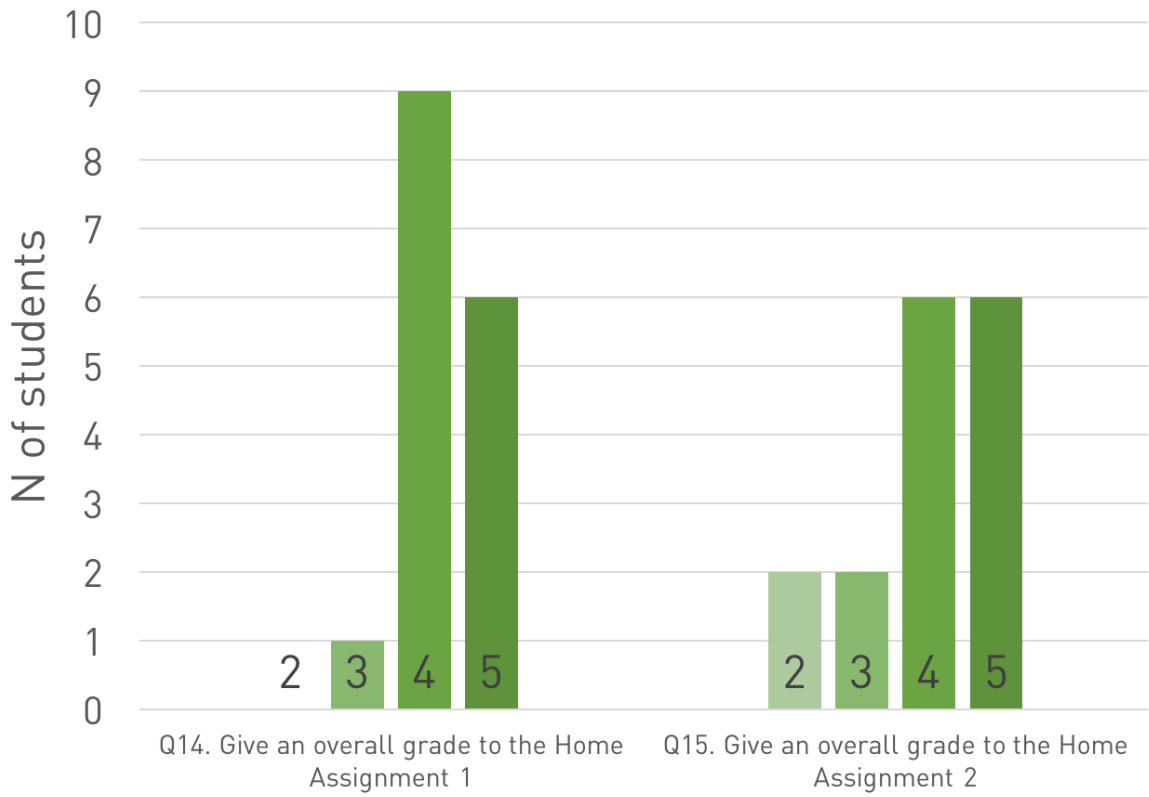
Q13.1 How useful the provided literature was?

Q13.2 How interesting the provided literature was?

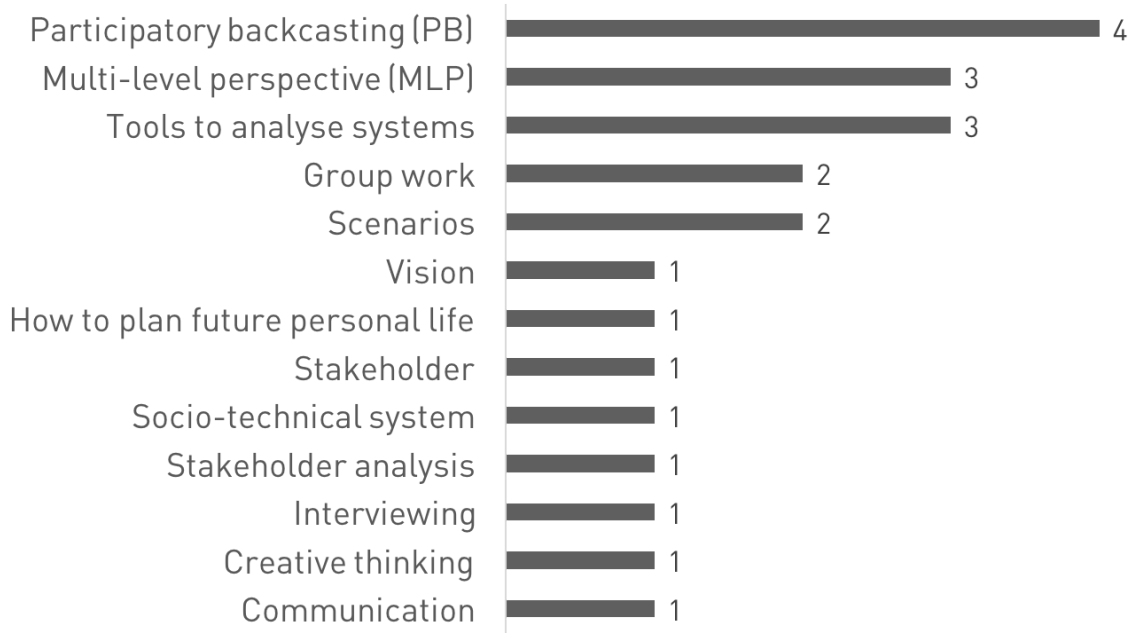
Individual home assignments (HA)

The HA1 was connected to the *Theme 1. MLP* and included application of MLP to the case of electric cars development in the USA.

The HA2 was connected to the *Theme 2. Transdisciplinarity* and to the interview part of the project work. It included the analysis of a given stakeholder group and the design of the questions to conduct an interview with a selected stakeholder.



What is the most valuable thing you have learned from the course?



Skills' evaluation

The course was intended to develop a number of sustainability change agents' skills among the students. The set of skills is based on the skills suggested in the literature on Engineering Education for Sustainable Development (e.g. Bath et al., 2007; Segalas, 2008; Svanstrom et al., 2008; Missimer and Connell, 2012; Hesselbarth and Schaaltegger, 2014; Mulder, 2014). The set of the skills includes:

- System thinking[1]
- Critical thinking
- Future orientation
- Transdisciplinarity[1]
- Personal involvement[1]
- Conflict resolution and consensus building
- Dealing with complexity
- Dealing with uncertainty
- Creativity
- Problem-solving
- Action skills

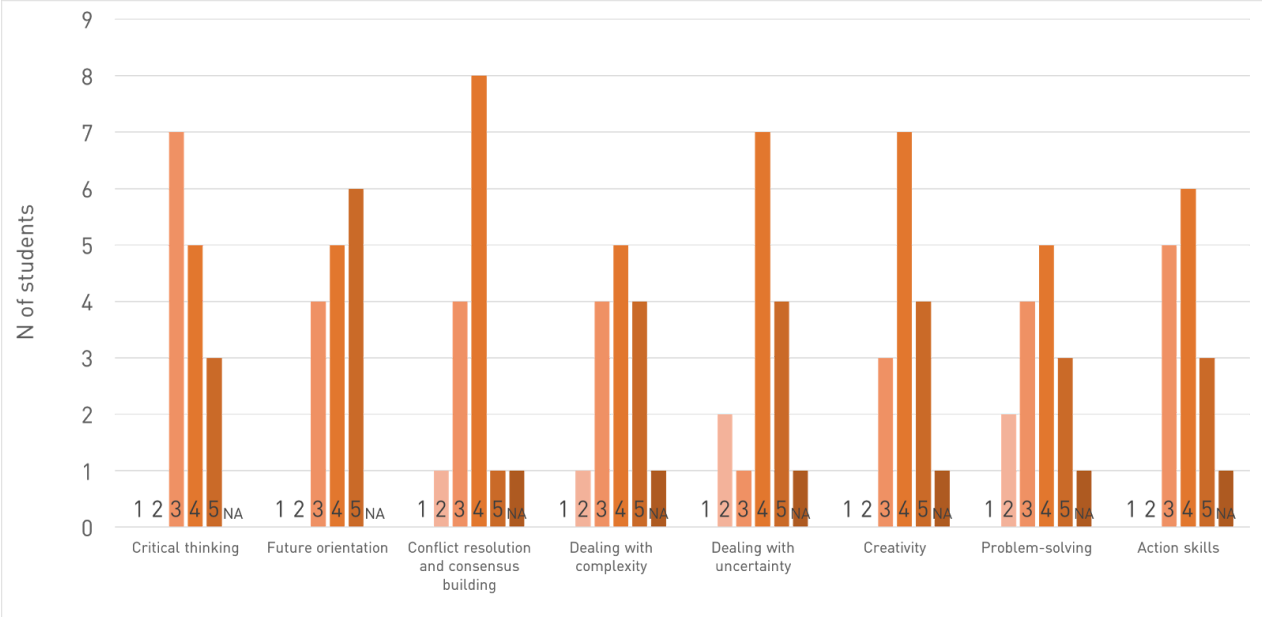
The level of acquired skills among the students was initially assessed through self-evaluation by the students, followed by the discussion with the reference group focusing mainly on the diversity in interpretations of the skills by the students.

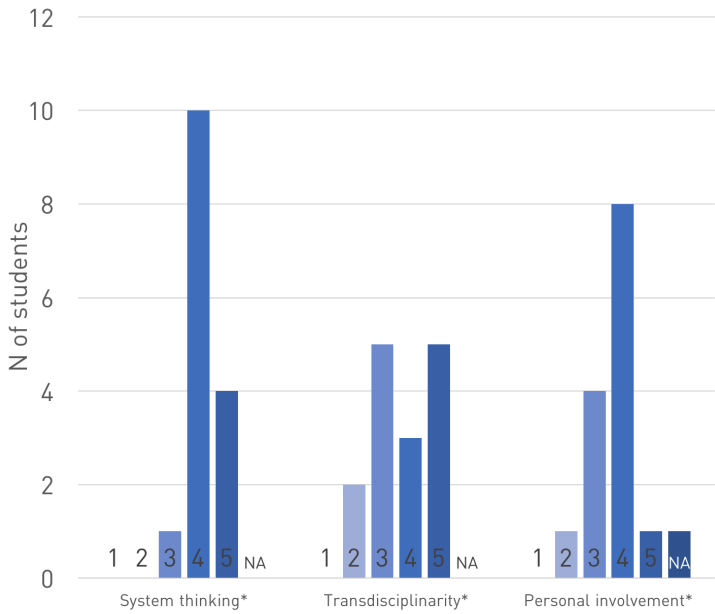
[1] During the final reference group meeting each skill has been discussed in order to identify how students have understood it when answering the corresponding question in the skill evaluation questionnaire.
The majority of the skills have been understood and approached by the students in a similar way - the reference group members could explain the meaning of these skills, relate them to the course and the project work in the similar way, and they have explicitly agreed with each others opinions.
However, regarding three skills namely *Systems thinking*, *Transdisciplinarity*, and *Personal involvement* a disagreement has been identified. The interpretation of the *Systems thinking* skill by different students varied significantly among the reference group members. In the case of *Personal involvement* skill, the students claim that they do not fully understand the meaning of this skill. Therefore, their answers might be misleading. Finally, regarding the skill *Transdisciplinarity* at least three different opinions have been identified - some students have referred to the integration of technological and social perspectives, others - to the integration of different disciplines, and others tackled this concept from the point of view of the integration of different stakeholders´ perspectives (the last is the closest to the definition of transdisciplinarity provided during the course).

The question for self-evaluation was formulated as following:

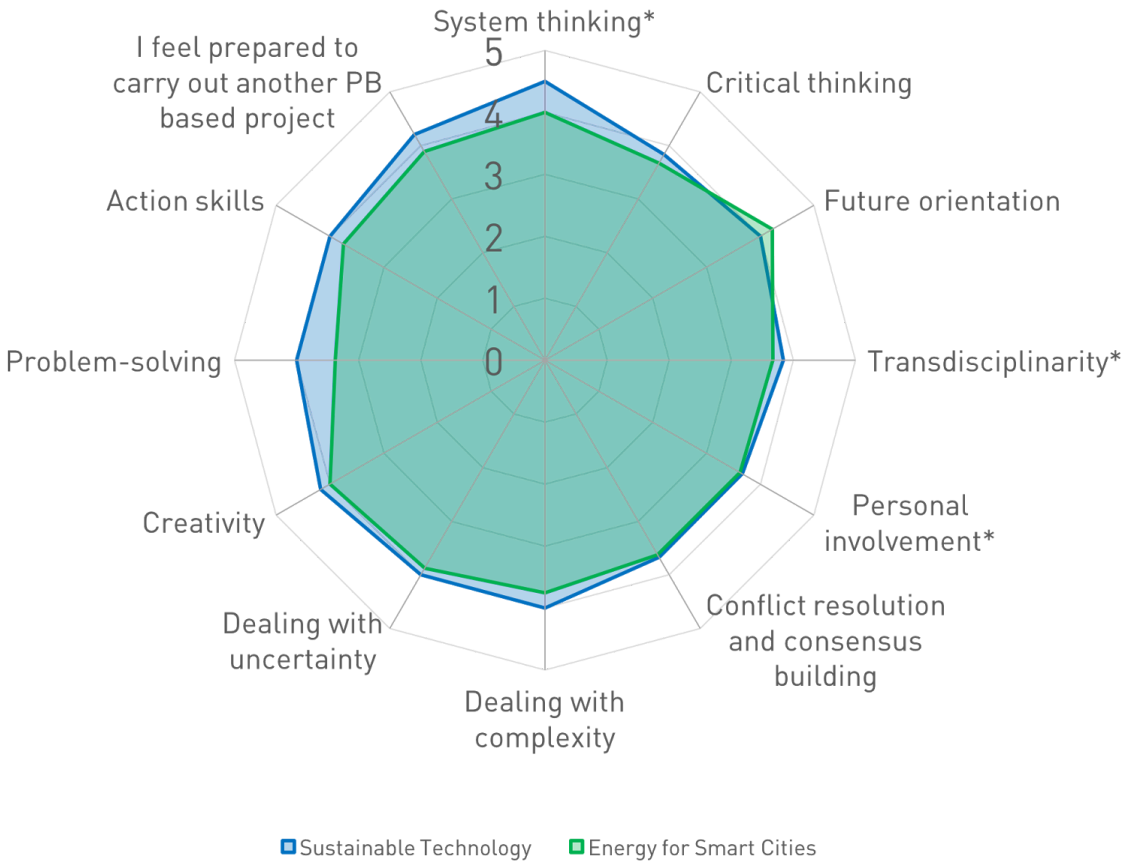
"I feel that the Participatory Backcasting-based project work within the course helped me to develop the following skills.
Please, tick one box for each skill listed in the table below to show how much you agree or disagree with the statement as applied to this skill."

The analysis of the skill self-evaluation is presented on the following two figures.





The course was attended by the students from two different MSc programs - Sustainable technology and Energy for Smart Cities. The figure below presents comparison between answers of students from these two programs.

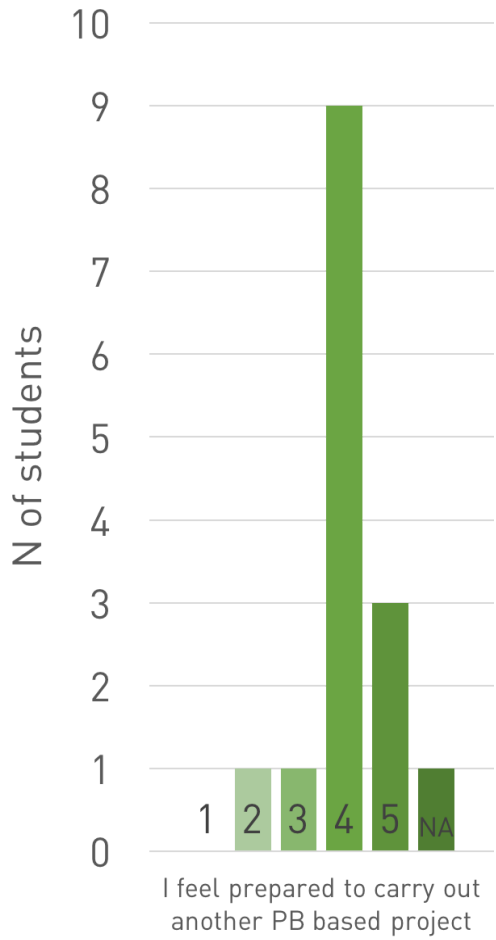


Overall learning of the PB framework

The skill evaluation questionnaire included a question regarding the overall learning of the PB framework of students. The question have been formulate as following:

"I feel prepared to carry out another Participatory Backcasting-based project for a socio-technical system similar to KTH campus."

The figure below presents analysis of the answers on this question. It can be seen that the majority of the students have agreed with the proposed statement. It is important to mention that the question was asked before the final reports were graded. It might be possible that the students' confidence in learning outcomes of the PB framework would be different if the question was asked after the reports' grading.



Analysis and conclusions

Overall, the course was evaluated positively by the students and IE teachers. The involved stakeholders and teachers from other departments have also been satisfied with the course organisation and the outcomes, including the Final project presentations.

Students' suggestions

In the course evaluation questionnaire, the students have pointed out a number of strengths of the course and suggested several issues to be improved. Students were asked to provide 3 strength of the course and 3 weaknesses to be improved. The table below shows the identified strengths and weaknesses and aggregated number of times when the same elements were named. The most often mentioned elements are specified in the table under each category.

Strengths

Content	**11**[2]

[2] Aggregated/total number of times mentioned

- socio-technical analysis,
- new concepts,
- new approach for problem solving,
- interesting topic of PW

Pedagogical approaches, teaching methods	**10**

- diversity of teaching methods,
- project based,
- good lectures,
- PW helps to understand theory

Organisation	**6**

- good staff,
- different locations,
- overall structure

Specific features	**6**

- challenging for system thinking,
- challenging for creative thinking,
- informative,
- practical,
- innovative

Tour around KTH campus	**5**
Environment	**4**

- creative way of working,
- good group dynamics,
- motivating environment

Critique	**2**

Weaknesses / Ways of improvement

Pedagogical approaches, teaching methods	**18**

- start the PW earlier in the course (from the beginning),
- clarify what is expected,
- clarify grading system,
- improve explanation of the concepts (slow down, more examples)

Organisation	**16**

- schedule,
- to extend course to two periods,
- decrease workload,

- decrease intensity,
- improve evaluation process,
- give more time

Content	**3**

- difficult concepts,
- topic of PW,
- emphasize vision and criteria

Specific features	**1**

- suggested interviewee didn't respond

Teacher team reflections

Based on the evaluation results of the home assignments and the project work, observations during the seminars, critique and final presentation, as well as students' evaluation of the course, the teacher team highlighted the following **four intervention themes** for course improvement: development of systems thinking skills; enhancing the project work; increasing requirements for data collection; elaboration of gender perspectives on design and innovation.

Systems thinking

The course has a higher potential for developing the *systems thinking* skill than we reached during the first edition of the course (2017). The identified reason is that the majority of the students did not have previous knowledge regarding the concepts of system, system approach or system theory. A number of the course seminars were dedicated to the tasks that are central for systems thinking, including identification of current system boundaries and possible transformations of the future system boundaries, which could change depending on new ways of fulfilling societal needs; analysis of influence of driving forces (external factors) on a system (internal parameters); analysis of long-term consequences of different possible system configurations, etc. However, the absence of basic knowledge on system analysis led to difficulties for students in fulfilling these advanced tasks. In the future, it would be valuable to evaluate students' background regarding the system thinking and system approach. An additional module on system analysis seems to be valuable, in particular, for Energy for Smart City Master students.

Project work

In the next edition of the course it is important to connect PB with MLP more explicitly within the Project work. The concept of the *socio-technical regime* is useful for explanation of the idea of system innovations. Landscape factors can be connected to driver analysis more explicitly. We will also consider the possibility connect HA1 to the Project work.

Another conclusion from this year is that the implementation of all 13 steps of the PB is time consuming and, consequently, very challenging in the time frame of the course (about 2,5 months). We will consider a possibility to simplify some of the steps to have more time for in depth elaboration of other steps.

It makes sense to start the Project work from the first or second activity within the course as it was suggested by many students. Students can be divided in groups and initiate a group work from the very beginning of the course.

It was initially planned that the topic for the project work will be changed every year to a new one. This year topic – KTH campus 2050 – turned out to be rather challenging due to the system complexity and diversity of the needs which are covered by the existing system. It became challenging for the students to encompass so many aspects of the system and relate them to each other. Topics for the next editions of the course could be focused on few selected system functions.

Data collection

This year data collection for the group work was supported by the teachers of the course to the great extent. The organisation of the tour around KTH campus and establishing contacts with stakeholders were mainly done by the course team. It was expected that the students would dedicate more time and efforts to additional data collection through search of relevant data in the literature and various sources. However, the group reports showed low diversity of the additional data sources, as well as lack of critical analysis of the collected data. We are going to develop approaches for encouraging students to make broader data search and critically analyse data collected through interviews.

Gender perspectives on design and innovation

To develop transdisciplinary approaches to innovation also means to advance gender equality and to address how gender-bias is constructed at various system-levels/ actor/network processes in future-oriented planning and innovation.

While these issues have been raised throughout the course, we believe there is room for improvement. We see the need to increase students' awareness of gender-related issues in the planning for sustainable societies and as it affects cultural relations. Gender equality calls for equal rights for women and men and equal entitlements to human, social, economic and cultural development. In future iterations of the course we will take stronger consideration to this by introducing literature and using dedicated seminars to work with the students on how gender and and inequality (diversity) is subtly enmeshed in the economic, cultural and social structures of society. Further, we will bring it is as a specific criteria for the evaluation of their project results and overall develop the awareness of ‘hegemonic masculinity’ inherent to power structures in society, restricting the development of alternatives in innovation - complex system of mutually reinforcing stereotypes supported by a whole range of social institutions and practices with profound effects on human thinking.

As a teaching team we will also inform ourselves further on gender analysis and on how central the fixing of gender identities is to the embedding of gender hierarchies and social relations of inequality in society and innovation projects. We believe that it is important to address theses issues fully interconnected with what current climate and energy

commitments entail, alongside other urgent issues relating to democracy, social and economic polarization, uneven distribution of resources etc.