Report - SF2822 - 2018-09-17

Respondents: 1
Answer Count: 1
Answer Frequency: 100.00 %

Please note that there is only one respondent to this form: the person that performs the course analysis.

Course analysis carried out by (name, e-mail):

Anders Forsgren, andersf@kth.se

COURSE DESIGN

Briefly describe the course design (learning activities, examinations) and any changes that have been implemented since the last course offering.

The course covers nonlinear programming. The course is based on projects, where students get training in modeling and analysis of practical problems, in addition to lectures and tutorials, where students get understanding of theory and methods. The second project is optionally an implementation project. This is the same setup as last year.

The group sizes for the project groups were two or three persons and the groups were selected by me. The projects are presented at a particular lecture. This presentations lecture is devoted to discussion between students. First, students having worked on the same project sat together and discussed. As a second part of the lecture, students having worked on different projects sat together and discussed, three persons in each group. In addition, we have the "follow-up" discussions with the groups after the presentation lectures.

As earlier years I used laptop and project as support for the teaching. This gives a "skeleton" of the course material. The slides are written using LaTeX. By the laptop I could also illustrate some example problems by using GAMS and Matlab.

Axel Ringh was teaching assistant, as last year.

THE STUDENT'S WORKLOAD

Does the students' workload correspond to the expected level (40 hours/1.5 credits)? If there is a significant deviation from the expected, what can be the reason?

Counting for ten weeks and 7.5 credits would give 20 hours per week. The students report a workload which is less, 12-14 hours a week would be the average. I think that the students think about the projects even when they do not work actively with them, so the workload i slightly higher. A rather large group of students report 6-8 hours per week, which I think is not sufficient, in general.

THE STUDENTS' RESULTS

How well have the students succeeded on the course? If there are significant differences compared to previous course offerings, what can be the reason?

The results on the exam was ok. First exam, in May, had 21 pass and 9 failed, out of 30. The second exam, in June, had 5 pass and 6 failed out of 20. There has been a trend of two groups, one that does very well, and one that almost fails or fails.

OVERALL IMPRESSION OF THE LEARNING ENVIRONMENT

What is your overall impression of the learning environment in the polar diagrams, for example in terms of the students' experience of meaningfulness, comprehensibility and manageability? If there are significant differences between different groups of students, what can be the reason?

The overall impression of the learning environment is good. This is in line with previous years.

ANALYSIS OF THE LEARNING ENVIRONMENT

Can you identify some stronger or weaker areas of the learning environment in the polar diagram - or in the response to each statement - respectively? Do they have an explanation?

Collaboration and support get high marks. I think this is due to the setup of the projects and the way we give feedback. Some students are not happy with the way the project groups are set up, since they do not have freedom to choose their group mates. I understand their point of view, but think there is an overall benefit of doing it the way it is done.

ANSWERS TO OPEN QUESTIONS

What emerges in the students' answers to the open questions? Is there any good advice to future course participants that you want to pass on?

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PRIORITY COURSE DEVELOPMENT

What aspects of the course should primarily be developed? How could these aspects be developed in the short or long term?

New projects are always useful. I would also be interested in developing some basic exercises for the students to do prior to the course, such as finding a basis for the nullspace of a matrix.

OTHER INFORMATION

Is there anything else you would like to add?

I enjoy very much giving this course. In general, I think it works very well. Axel Ringh is a good teaching assistant.

Course data 2018-09-18

SF2822 - Applied Nonlinear Optimization, VT 2018 Doktorand

Course facts

Course start:	2018 w.12
Course end:	2018 w.23
Credits:	7,5
Examination:	PRO1 - Project, 1.5, Grading scale: A, B, C, D, E, FX, F PRO2 - Project, 1.5, Grading scale: A, B, C, D, E, FX, F TEN1 - Examination, 4.5, Grading scale: A, B, C, D, E, FX, F
Grading scale:	A, B, C, D, E, FX, F

Staff

Examiner:	Anders Forsgren <andersf@kth.se>
Course responsible teacher:	Anders Forsgren <andersf@kth.se>
Teachers:	Anders Forsgren <andersf@kth.se>
Assistants:	

Number of students on the course offering

First-time registered:	3
Total number of registered:	11

Achievements (only first-time registered students)

Pass rate[1] [%]	33.30%
Performance rate[2] [%]	33.30%
Grade distribution[3] [%, number]	B 100% (1)

1 Percentage approved students
2 Percentage achieved credits
3 Distribution of grades among the approved students

SF2822 - Applied Nonlinear Optimization, VT 2018

Course facts

Course start:	2018 w.12
Course end:	2018 w.23
Credits:	7,5
Examination:	PRO1 - Project, 1.5, Grading scale: A, B, C, D, E, FX, F PRO2 - Project, 1.5, Grading scale: A, B, C, D, E, FX, F TEN1 - Examination, 4.5, Grading scale: A, B, C, D, E, FX, F
Grading scale:	A, B, C, D, E, FX, F

Staff

Examiner:	Anders Forsgren <andersf@kth.se>
Course responsible teacher:	Anders Forsgren <andersf@kth.se>
Teachers:	Anders Forsgren <andersf@kth.se> Axel Ringh <aringh@kth.se>
Assistants:	Axel Ringh <aringh@kth.se>

Number of students on the course offering

First-time registered:	35
Total number of registered:	43

Achievements (only first-time registered students)

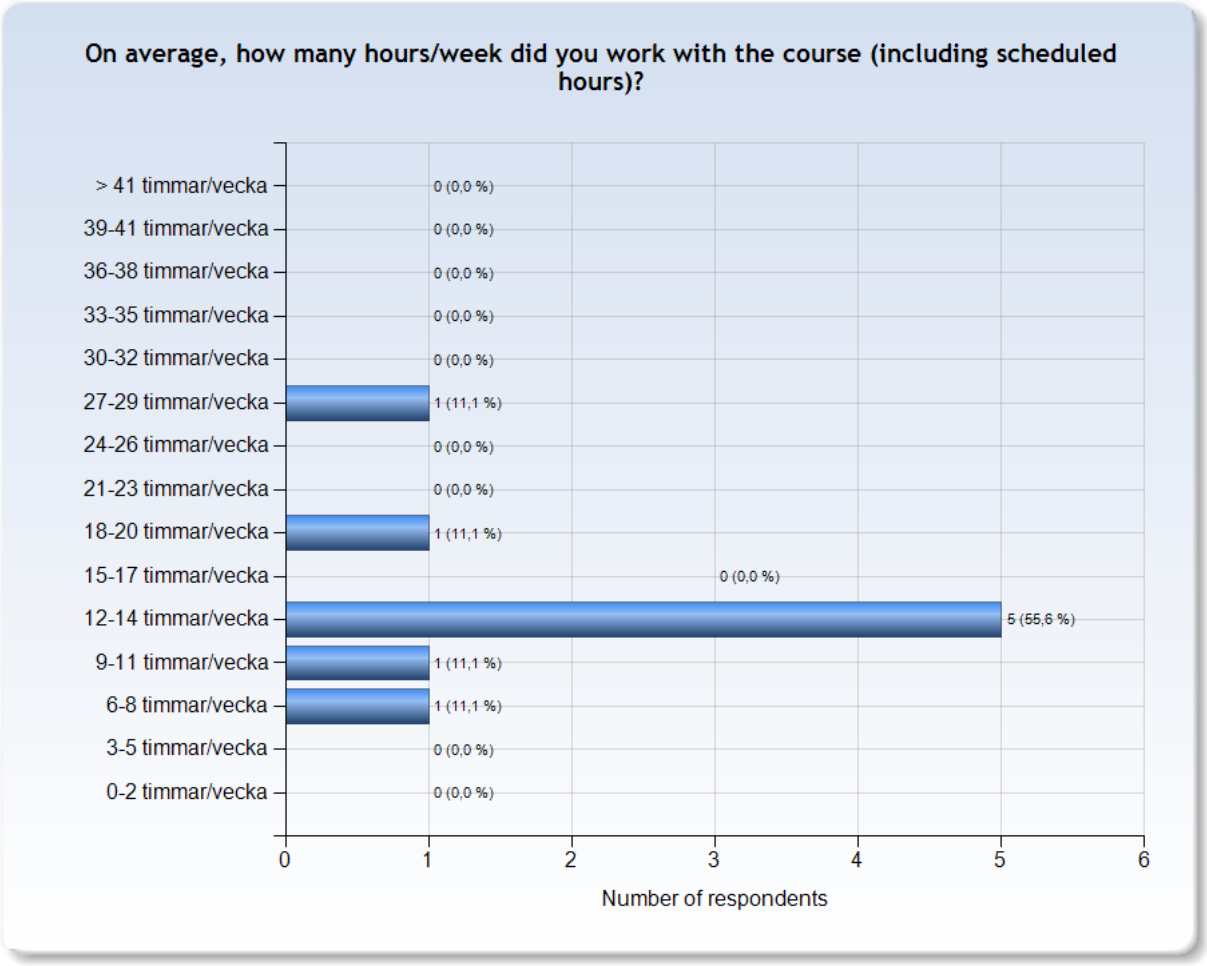
Pass rate[1] [%]	51.40%
Performance rate[2] [%]	69.10%
Grade distribution[3] [%, number]	A 44% (8) B 28% (5) C 22% (4) D 6% (1)

1 Percentage approved students
2 Percentage achieved credits
3 Distribution of grades among the approved students

SF2822 - 2018-06-04

Antal respondenter: 37
Antal svar: 9
Svarsfrekvens: 24,32 %

ESTIMATED WORKLOAD



Comments

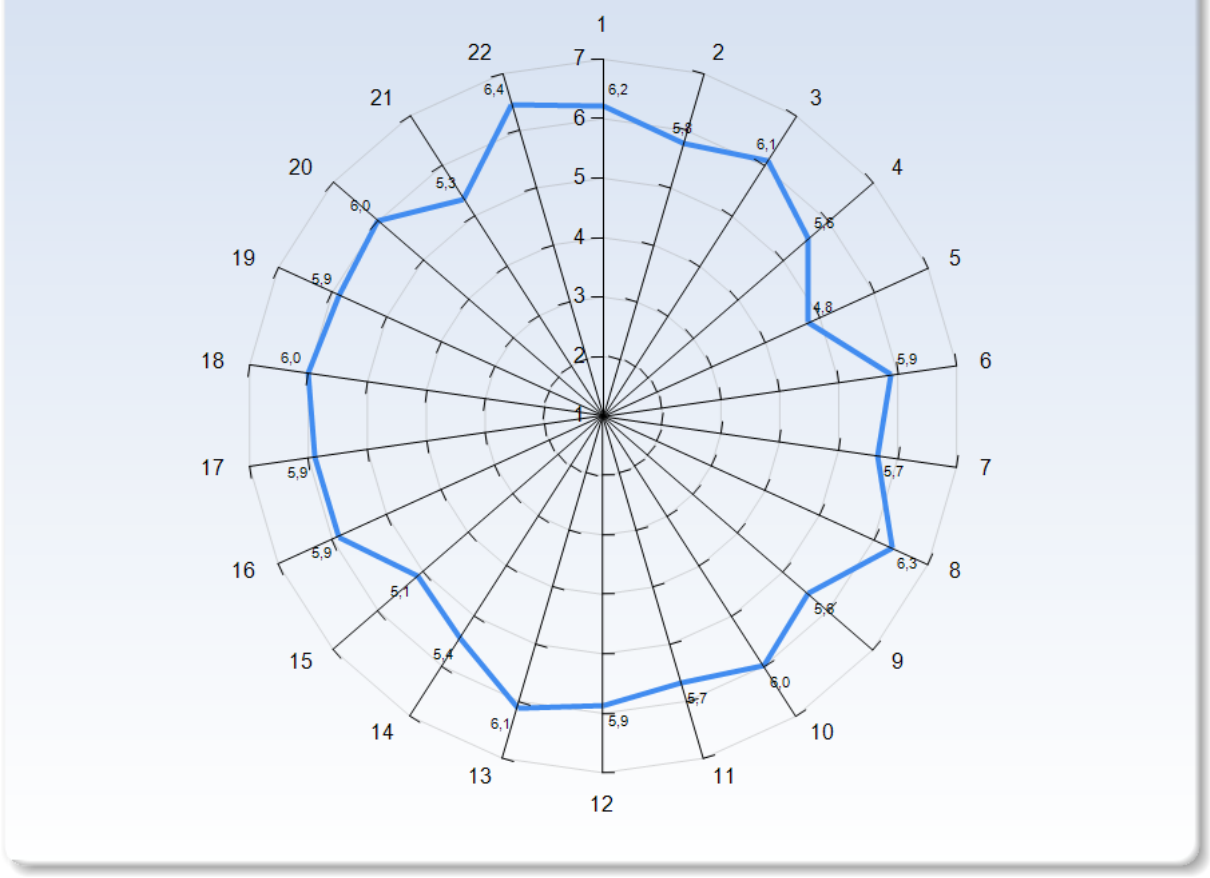
Comments (I worked: 12-14 timmar/vecka)
Not very much in the beginning but more during the projects.
Workload increases, naturally, around project hand-ins.

LEARNING EXPERIENCE

The polar diagrams below show the average response to the LEQ statements for different groups of respondents (only valid responses are included). The scale that is used in the diagrams is defined by:

1 = No, I strongly disagree with the statement
4 = I am neutral to the statement
7 = Yes, I strongly agree with the statement

Note! A group has to include at least 3 respondents in order to appear in a diagram.


Average response to LEQ statements - all respondents
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
7
6
5
4
3
2
1
6,2
5,8
6,1
5,5
4,8
5,9
5,7
6,3
5,8
6,0
5,7
5,9
6,1
5,4
5,1
5,9
5,9
6,0
5,3
6,0
5,9
6,4

KTH Learning Experience Questionnaire v3.1.3

Meaningfulness - emotional level

Stimulating tasks

1. I worked with interesting issues (a)

Exploration and own experience

2. I explored parts of the subject on my own (a)
3. I was able to learn by trying out my own ideas (b)

Challenge

4. The course was challenging in a stimulating way (c)

Belonging

5. I felt togetherness with others on the course (d)
6. The atmosphere on the course was open and inclusive (d)

Comprehensibility - cognitive level

Clear goals and organization

7. The intended learning outcomes helped me to understand what I was expected to achieve (e)
8. I understood how the course was organized and what I was expected to do (e)

Understanding of subject matter

9. I understood what the teachers were talking about (f)
10. I was able to learn from concrete examples that I could relate to (g)
11. Understanding of key concepts had high priority (h)

Constructive alignment

12. The course activities helped me to achieve the intended learning outcomes efficiently (i)
13. I understood what I was expected to learn in order to obtain a certain grade (i)

Feedback and security

14. I received regular feedback that helped me to see my progress (j)
15. I could practice and receive feedback without being graded (j)
16. The assessment on the course was fair and honest (k)

Manageability - instrumental level

Sufficient background knowledge

17. My background knowledge was sufficient to follow the course (f)

Time to reflect

18. I regularly spent time to reflect on what I learned (l)

Variation and choices

19. I was able to learn in a way that suited me (m)
20. I had opportunities to choose what to do (m)

Collaboration

21. I was able to learn by collaborating and discussing with others (n)

Support

22. I was able to get support if I needed it (c)

Learning factors from the literature that LEQ intends to examine

We tend to learn most effectively (in ways that make a sustained, substantial, and positive influence on the way we think, reflect, act or feel) when:

a) We are trying to answer questions, solve problems or acquire skills that we find interesting, intriguing or important

b) We can speculate, try out ideas (intellectually or practically) and learn from experience, even before we know much about the subject

c) We are able to do so in a challenging yet supportive environment

d) We feel that we are part of a community and believe that other people have faith in our ability to learn

e) We understand the meaning of the intended learning outcomes, how the environment is organized and what is expected of us

f) We have sufficient background knowledge to manage the present learning situation

g) We can learn inductively by moving from specific examples and experiences to general principles, rather than the other way around

h) We are challenged to develop a proper understanding of key concepts and successively create a coherent whole of the content

i) We believe that the work we are expected to do will help us to reach the intended learning outcomes

j) We can try, fail, and receive feedback in advance of and separate from any summative judgment of our efforts

k) We believe that our work will be considered fairly and honestly

l) We have sufficient time to learn and devote the time necessary to do so

m) We believe that we are in control of our own learning, not manipulated

n) We can work collaboratively with other learners struggling with the same problems

Literature

Bain, K. (2004). *What the Best College Teachers Do*, Chapter 5, pp. 98-134. Cambridge: Harvard University Press.

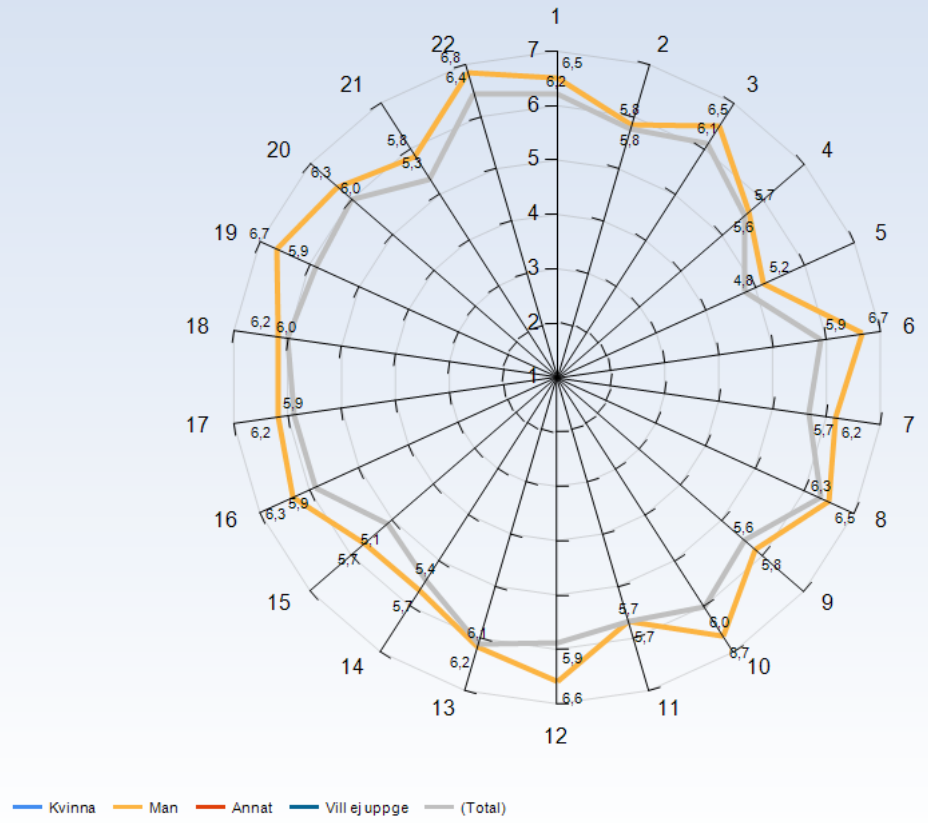
Biggs J. & Tang, C. (2011). *Teaching for Quality Learning at University*, Chapter 6, pp. 95-110. Maidenhead: McGraw Hill.

Elmgren, M. & Henriksson, A-S. (2014). *Academic Teaching*, Chapter 3, pp. 57-72. Lund: Studentlitteratur.

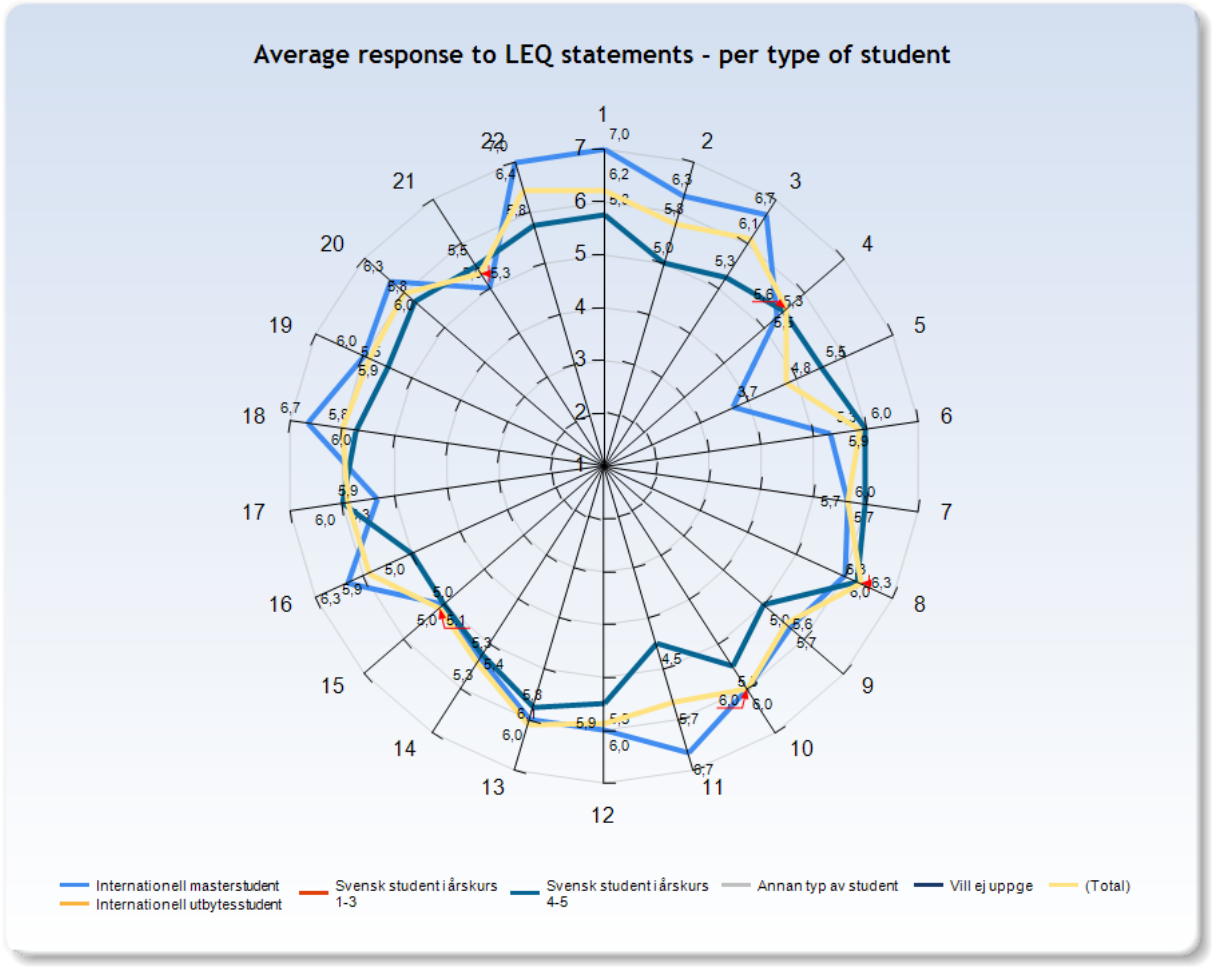
Kember, K. & McNaught, C. (2007). *Enhancing University Teaching: Lessons from Research into Award-Winning Teachers*, Chapter 5, pp. 31-40. Abingdon: Routledge.

Ramsden, P. (2003). *Learning to Teach in Higher Education*, Chapter 6, pp. 84-105. New York: RoutledgeFalmer.

Average response to LEQ statements - per gender



Comments



Comments

Comments (I am: Internationell masterstudent)
I am a dual master student between KTH and UCL (Belgium). I did my bachelor at UCL.

GENERAL QUESTIONS

What was the best aspect of the course?

What was the best aspect of the course? (I worked: 9-11 timmar/vecka)
I really liked the projects. Those were fun to think about and figure out (except for writing the report. that was annoying, but also helpful to sort out thoughts). Especially the last one, where we had to model traffic was fun.
The lectures were in general easy to follow but not boring.

What was the best aspect of the course? (I worked: 12-14 timmar/vecka)
Nice with the opportunity to do a project in Matlab, it enhanced my understanding of the algorithm.
Interesting projects which however were extremely time consuming
The course was extremely well organized and easy to follow. It was possible to learn a lot from it without investing too much time in it, since everything (learning outcomes, content of the lectures, etc.) was crystal clear.
Fun and relaxed lectures and exercises! It was actually fun going to the lectures, which not happens in too many courses.
The exercise sessions were excellent. Axel provided clear insight into the algorithms used and how they worked.

What was the best aspect of the course? (I worked: 27-29 timmar/vecka)
Exercise sessions and to a certain extent the projects.

What would you suggest to improve?

What would you suggest to improve? (I worked: 9-11 timmar/vecka)
The first lectures were very rushed and theory laden. I think the whole concept of lagrangians and optimality conditions could have been introduced in a bit more detail, and then put less detail into later derivations - which were often the same thing over and over again. It confused me, why we could use optimality conditions of a relaxed problem equivalently to the optimality condition of the original one, and not only as a lower bound.

What would you suggest to improve? (I worked: 12-14 timmar/vecka)
Since I read the linear course before this, I knew how GAMS worked, but I am not sure it was as easy for beginners. Maybe it would be better with a more intuitive first project.
More useful project 1, it was hard to grasp the problem
The course was by far too easy. I am following a dual master between KTH and UCL (Belgium). I did my bachelor at UCL. At that university, all engineering students (400 people per year) have one year and a half of common courses. Then, each student chooses two fields he wants to specialize in. I chose to specialize in applied mathematics and mechanics. Therefore, I already had an optimization course in my second year of bachelor. This course was only 5 credits and covered both linear and non-linear optimization. However, the course SF2822, which is a master course of 7.5 credits, did not go a lot further than the non-linear part of the course I had in UCL. For example, why didn't we talk about the computational complexity of the methods ? Why didn't we analyze limit cases, convergence issues and so on ? Or simply, why didn't we cover more material since the course is worth as many as 7.5 credits ? Indeed, the workload of this course would correspond to a course of 4 credits at UCL.
Nothing that I can think of really.

What would you suggest to improve? (I worked: 27-29 timmar/vecka)
The groups. Sometimes groups don't work, this is because people are different. Being from different countries is sometimes not a good thing, as a matter of fact communication often lacks. It's difficult to work with someone who behaves as hostile towards you. To me there was no togetherness. In addition to this, many groups work as follows: one student does all the code and the others only do the report. This was not my case, but I heard 4-5 people telling me this. My case was even worse : I was let alone. So a different way of forming groups is a good improvement. I would suggest ask every person to list 1 to 5 other students they would like to work with. Then make the groups of 4 people si everyone works at least with someone is happy to work with and 2 other people he/she doesn't know.

What advice would you like to give to future participants?

What advice would you like to give to future participants? (I worked: 9-11 timmar/vecka)
Review Taylor expansion in higher dimensions.

What advice would you like to give to future participants? (I worked: 12-14 timmar/vecka)
Study in time
Spend time on the theory questions
Invest yourselves in the projects, it's the most fun part of the course ! Besides, working on project 2B (implementation) is an excellent way of learning a lot of material required for the exam.
Start with the projects early! Also look through the slides of each lecture before going to it in order to keep up better and maybe think of some questions beforehand.
Do not let the mathematics itself scare you off if you are not fully familiar with the details.

What advice would you like to give to future participants? (I worked: 27-29 timmar/vecka)
PRactice in exercises from the beginning and do the theory questions

Is there anything else you would like to add?

Is there anything else you would like to add? (I worked: 9-11 timmar/vecka)
I really, really dislike that we have to hand in a self-assessment for the projects. Especially the last one was really unbalanced in our group, but you don't want to be the one to point your finger and make the other person get a worse grade. But I also don't like to lie so blatantly and write "yes. all people worked the same amount" when one person didn't contribute at all. A group project is something, where the whole group gets judged, so I think it's fair to give all of the group members the same grade no matter how the work was distributed. If you want to grade individually, how about people write their name under the section they most contributed to, that would make it a bit more fair, in my opinion (it would also motivate a few students to work more).

Is there anything else you would like to add? (I worked: 12-14 timmar/vecka)
Very good exercices
The theory questions should be provided with answers. I though I had copied the whole proof correctly but getting back my test I realized that wasn't the case.
Keep on going in the same way. Both the nonlinear and linear course were among the funniest courses I have read!

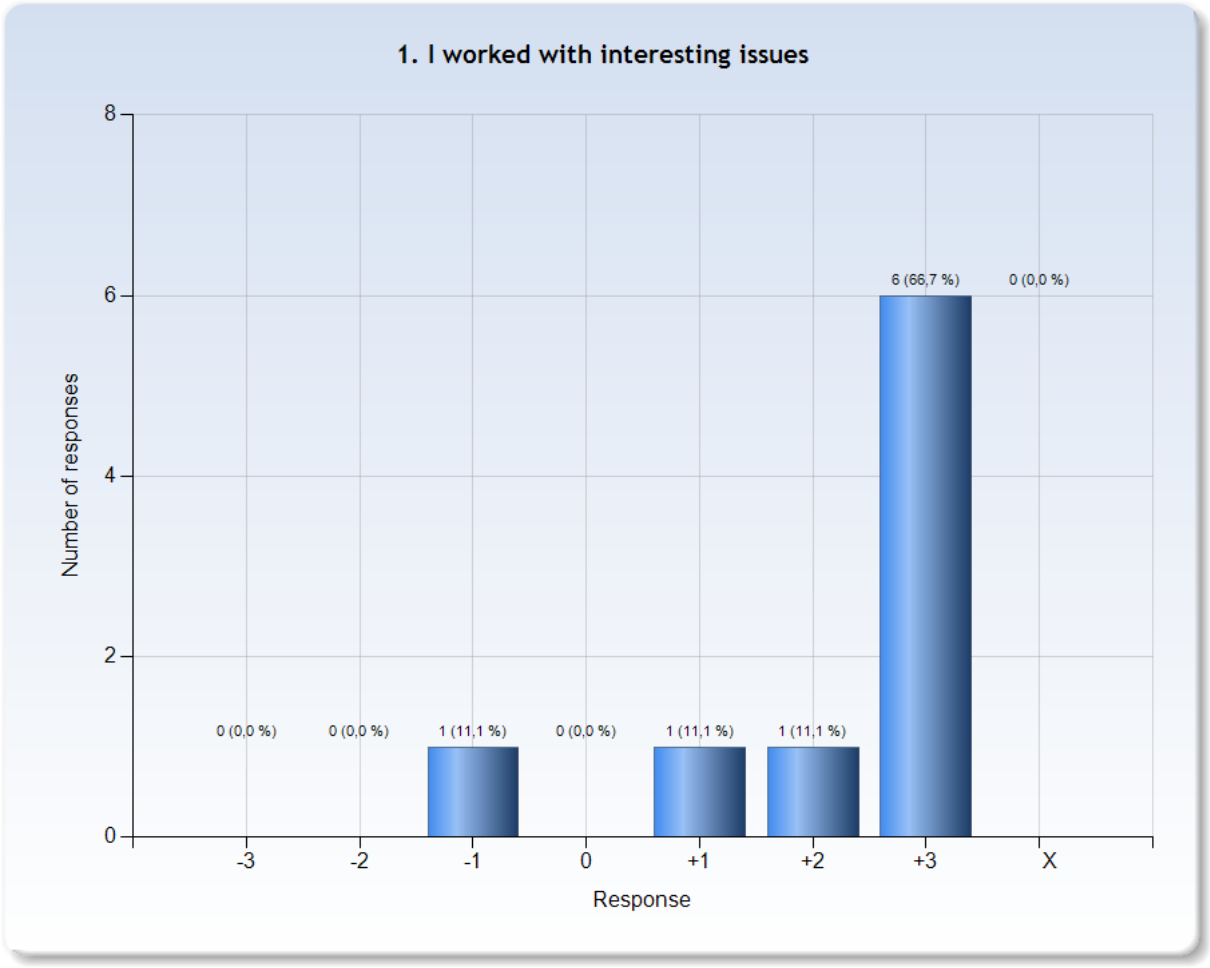
SPECIFIC QUESTIONS

RESPONSE DATA

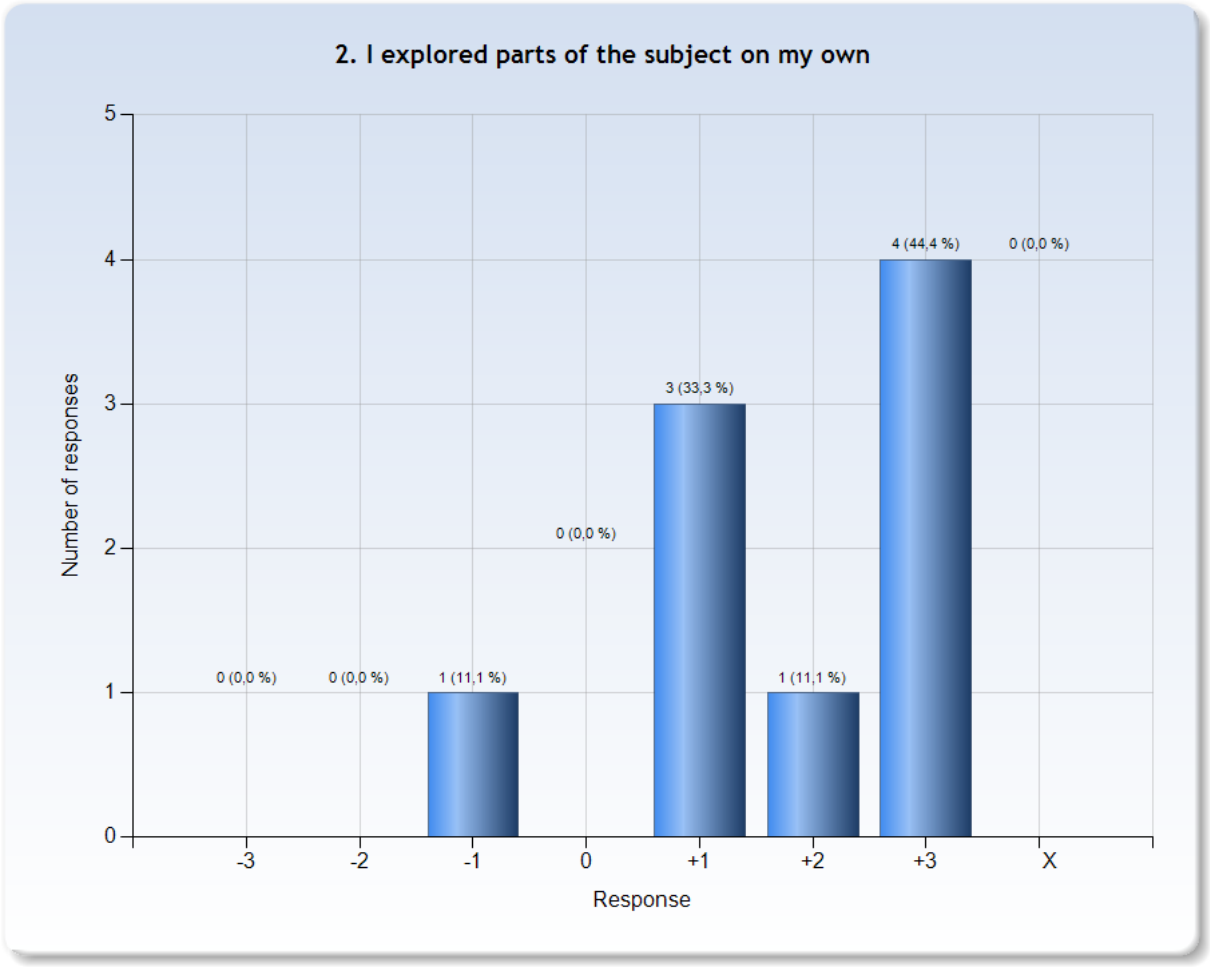
The diagrams below show the detailed response to the LEQ statements. The response scale is defined by:

-3 = No, I strongly disagree with the statement
0 = I am neutral to the statement
+3 = Yes, I strongly agree with the statement

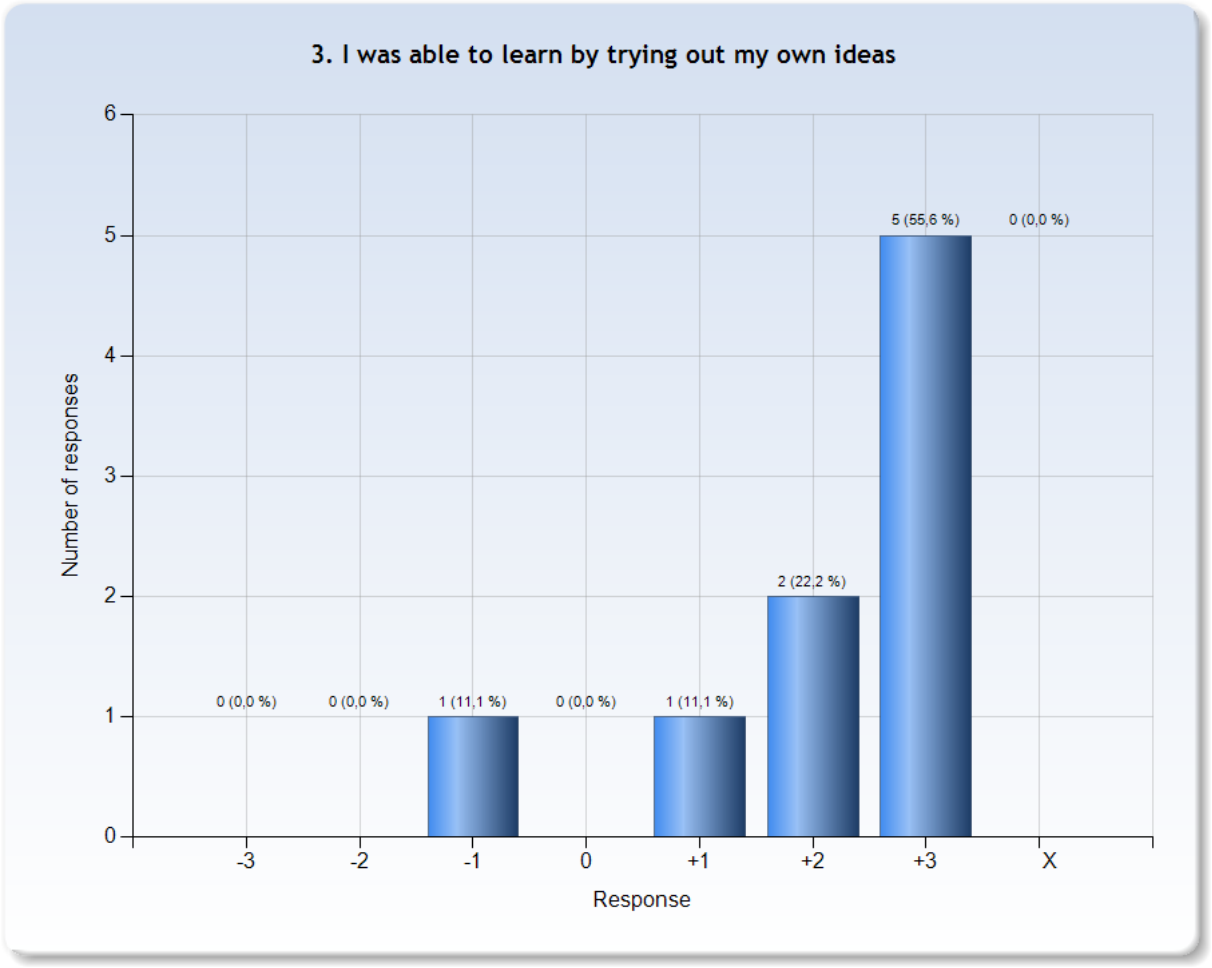
X = I decline to take a position on the statement


1. I worked with interesting issues
Number of responses
Response
0
2
4
6
8
-3
-2
-1
0
+1
+2
+3
X
0 (0,0 %)
0 (0,0 %)
1 (11,1 %)
0 (0,0 %)
1 (11,1 %)
1 (11,1 %)
6 (66,7 %)
0 (0,0 %)

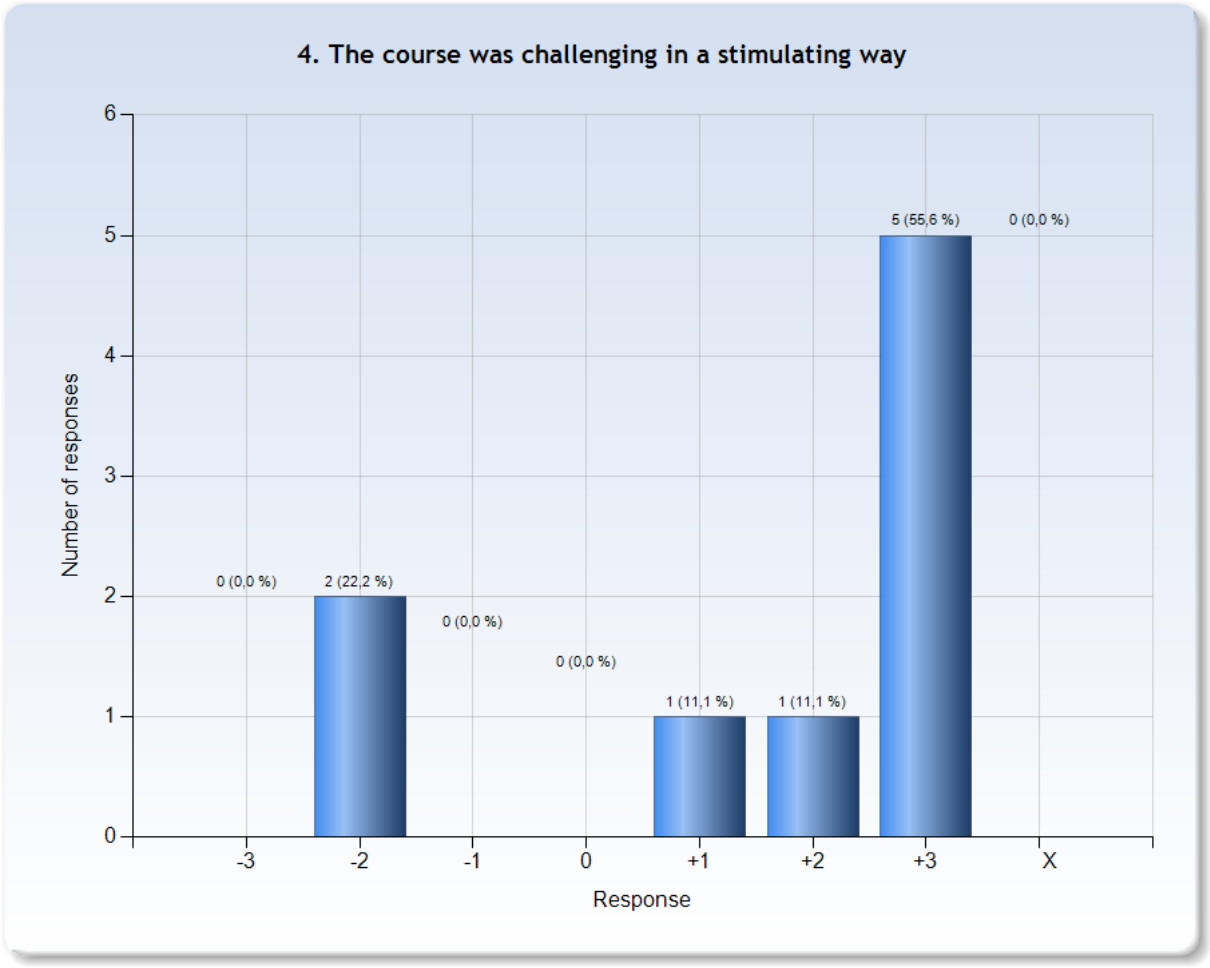
Comments


2. I explored parts of the subject on my own
Number of responses
Response
0
1
2
3
4
5
-3
-2
-1
0
+1
+2
+3
X
0 (0,0 %)
0 (0,0 %)
1 (11,1 %)
0 (0,0 %)
3 (33,3 %)
1 (11,1 %)
4 (44,4 %)
0 (0,0 %)

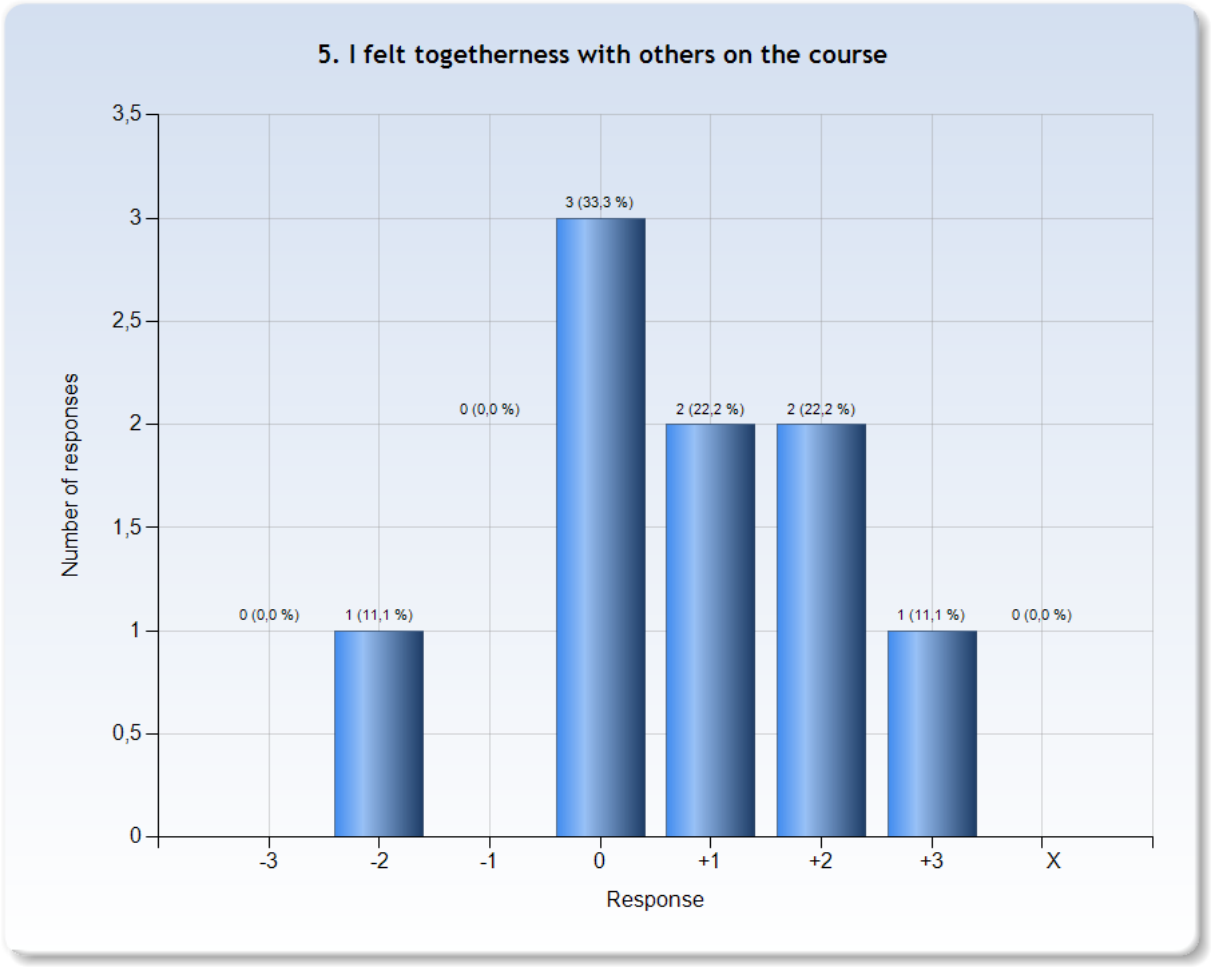
Comments


3. I was able to learn by trying out my own ideas
Number of responses
Response
0 (0,0 %)
0 (0,0 %)
1 (11,1 %)
0 (0,0 %)
1 (11,1 %)
2 (22,2 %)
5 (55,6 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X

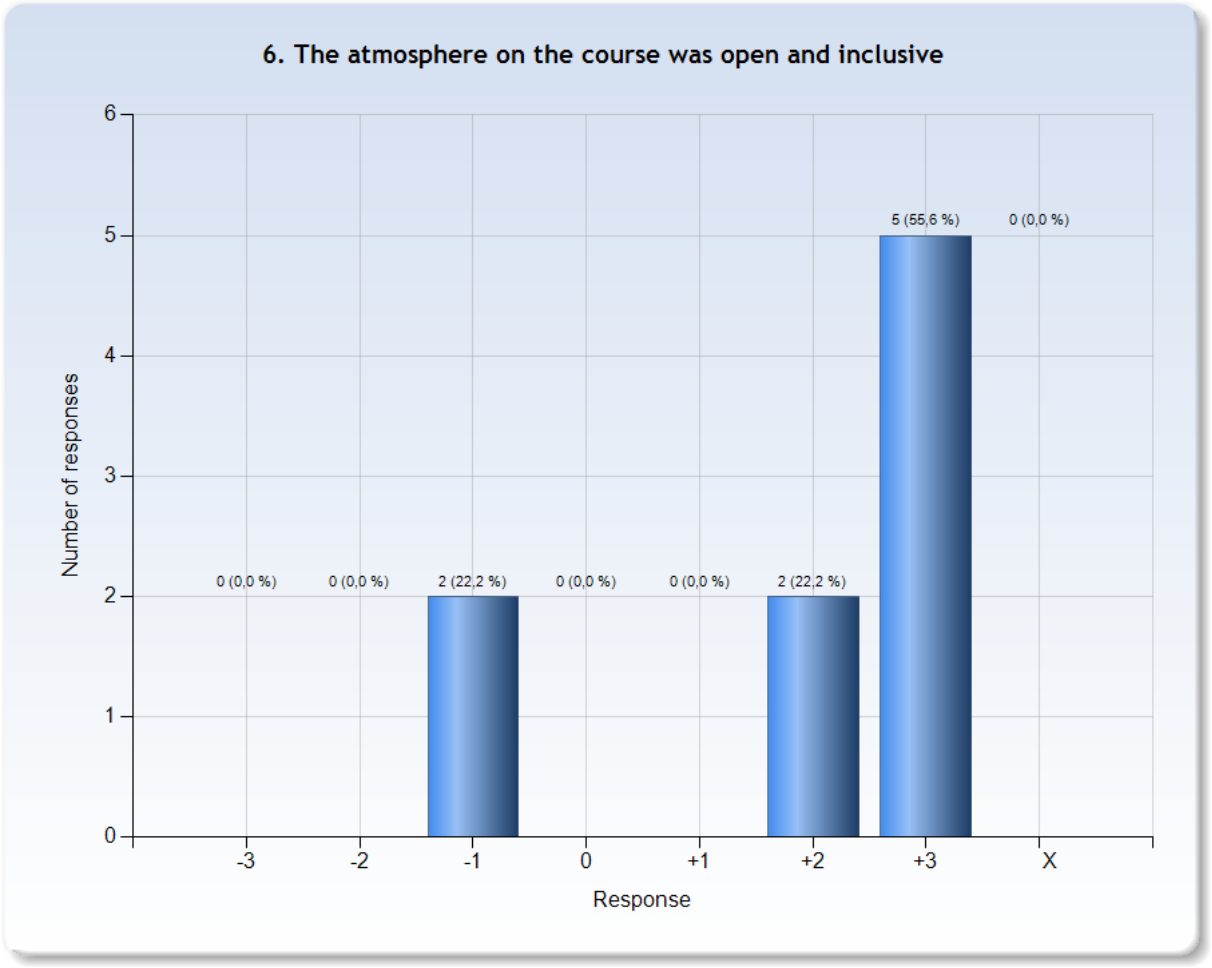
Comments


4. The course was challenging in a stimulating way
Number of responses
Response
0 (0,0 %)
2 (22,2 %)
0 (0,0 %)
0 (0,0 %)
1 (11,1 %)
1 (11,1 %)
5 (55,6 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X

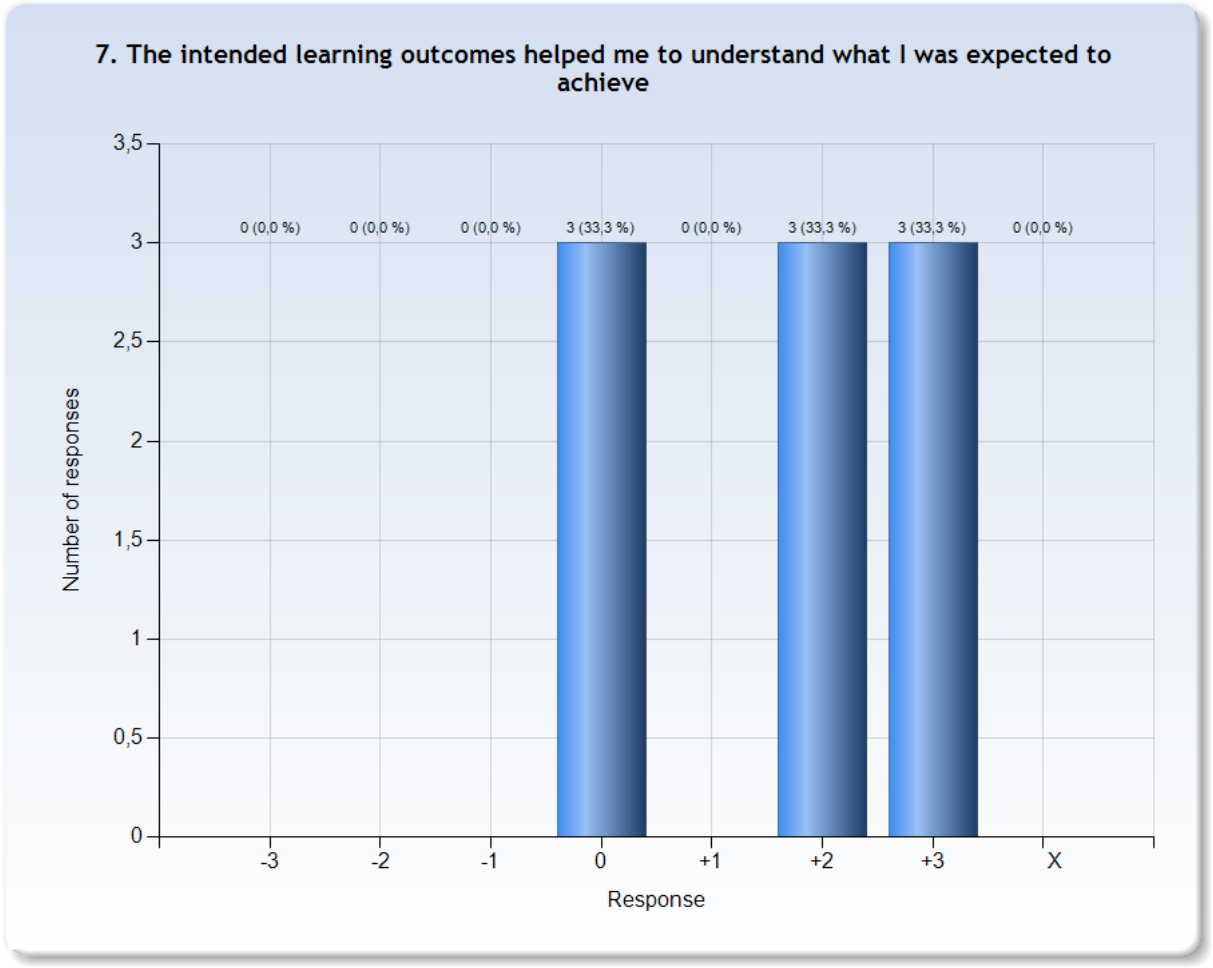
Comments


5. I felt togetherness with others on the course
Number of responses
3,5
3
2,5
2
1,5
1
0,5
0
0 (0,0 %)
1 (11,1 %)
0 (0,0 %)
3 (33,3 %)
2 (22,2 %)
2 (22,2 %)
1 (11,1 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X
Response

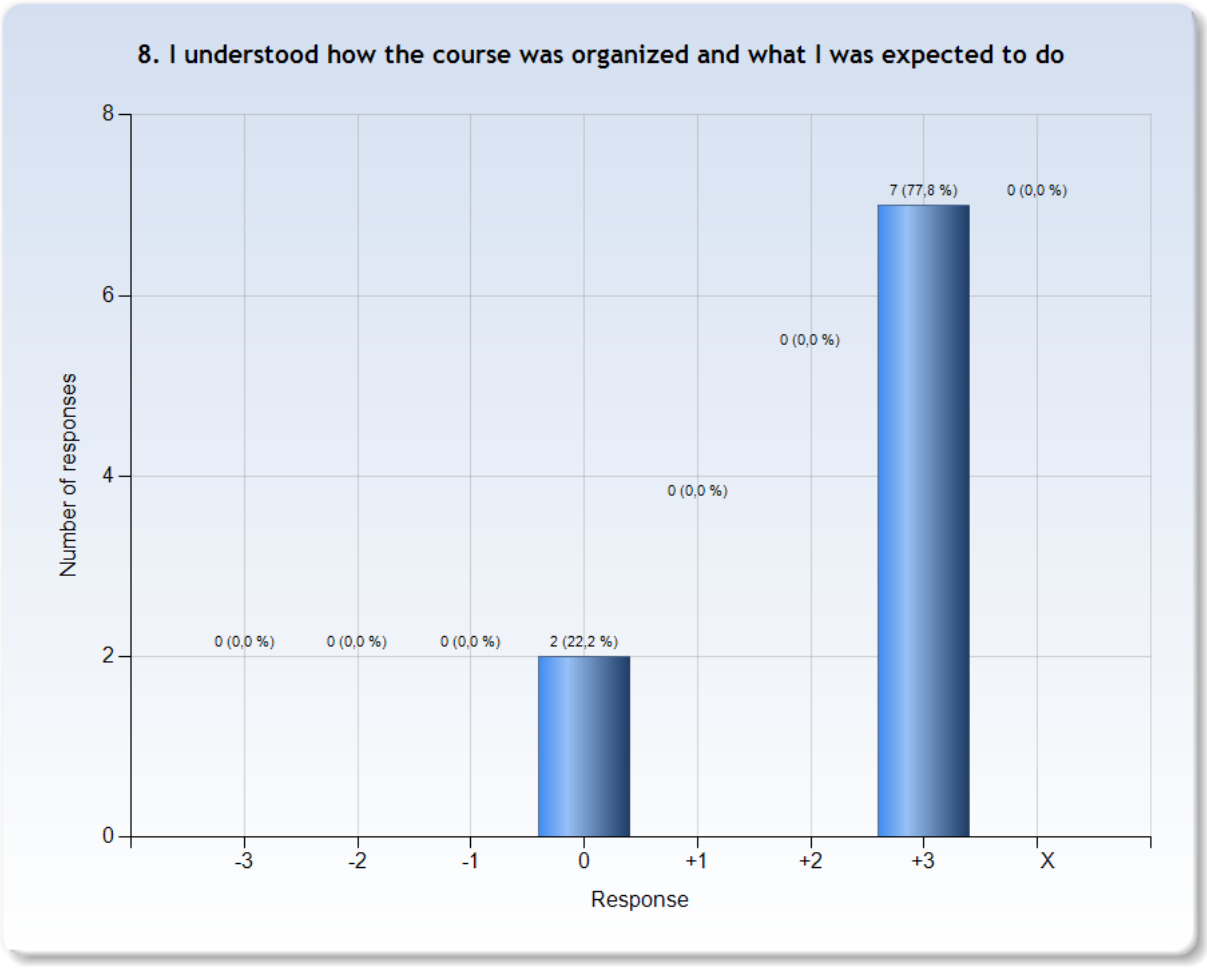
Comments


6. The atmosphere on the course was open and inclusive
Number of responses
0
1
2
3
4
5
6
0 (0,0 %)
0 (0,0 %)
2 (22,2 %)
0 (0,0 %)
0 (0,0 %)
2 (22,2 %)
5 (55,6 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X
Response

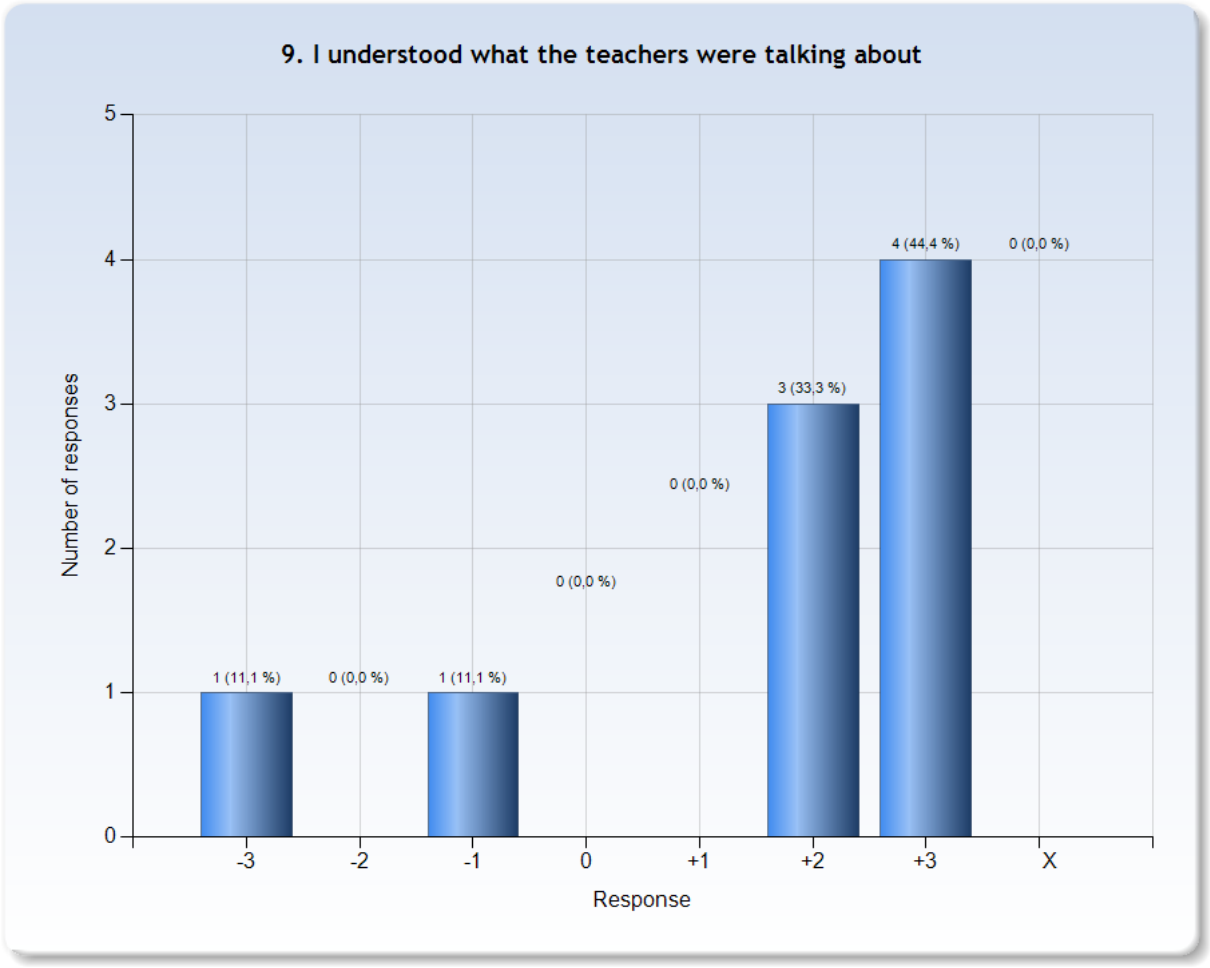
Comments


7. The intended learning outcomes helped me to understand what I was expected to achieve
Number of responses
3,5
3
2,5
2
1,5
1
0,5
0
0 (0,0 %)
0 (0,0 %)
0 (0,0 %)
3 (33,3 %)
0 (0,0 %)
3 (33,3 %)
3 (33,3 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X
Response

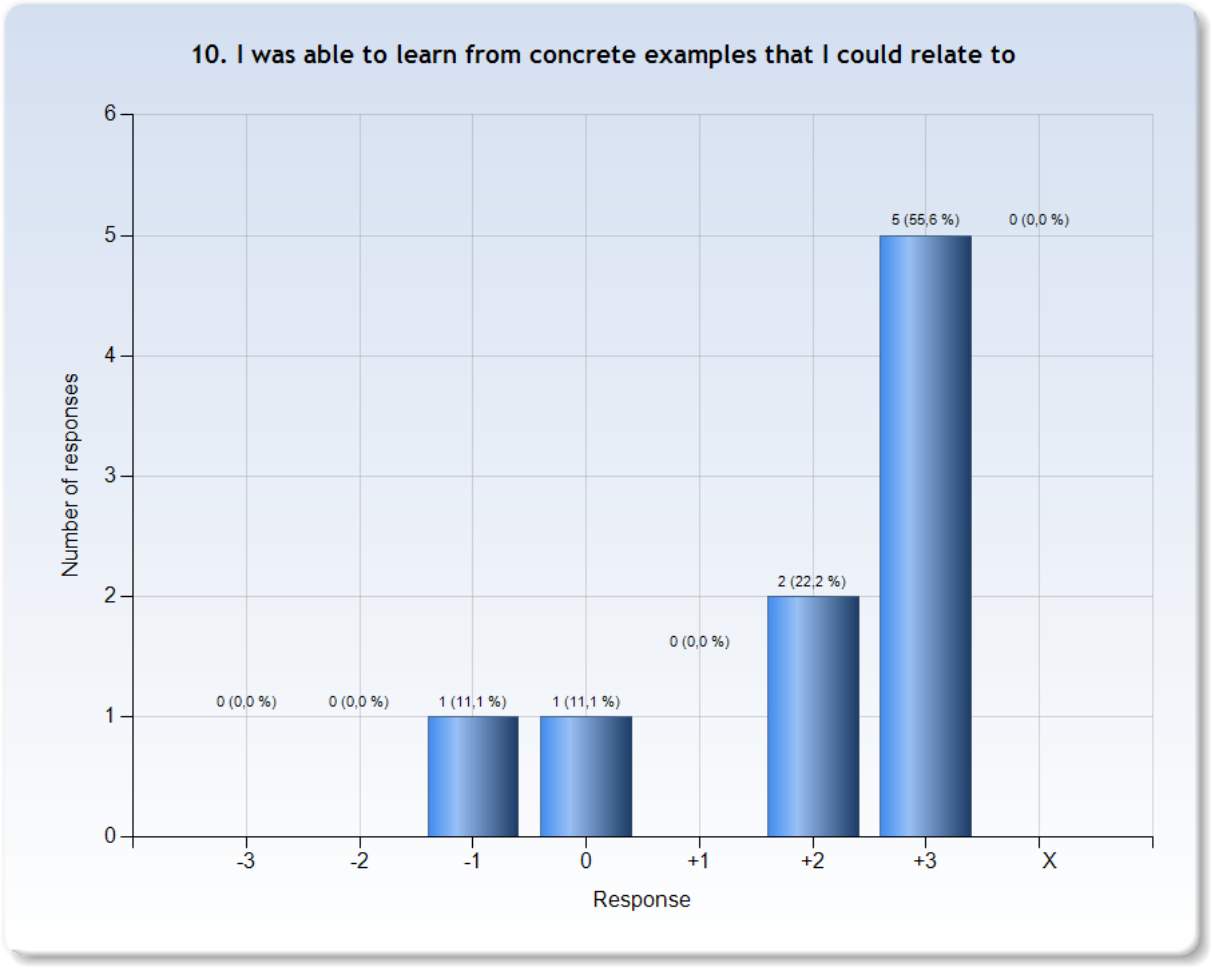
Comments


8. I understood how the course was organized and what I was expected to do
Number of responses
8
6
4
2
0
0 (0,0 %)
0 (0,0 %)
0 (0,0 %)
2 (22,2 %)
0 (0,0 %)
0 (0,0 %)
7 (77,8 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X
Response

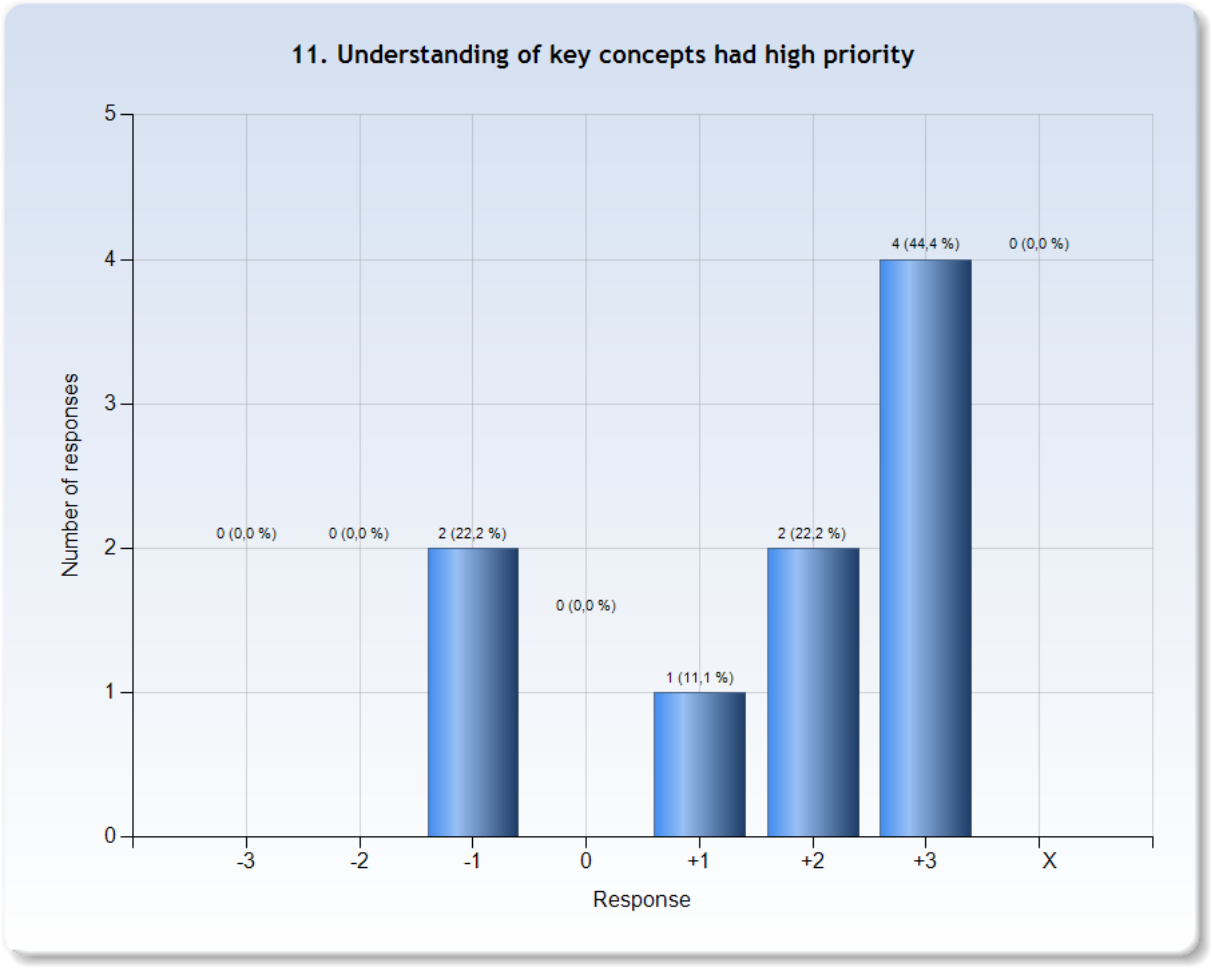
Comments


9. I understood what the teachers were talking about
Number of responses
Response
5
4
3
2
1
0
-3
-2
-1
0
+1
+2
+3
X
1 (11,1 %)
0 (0,0 %)
1 (11,1 %)
0 (0,0 %)
0 (0,0 %)
3 (33,3 %)
4 (44,4 %)
0 (0,0 %)

Comments

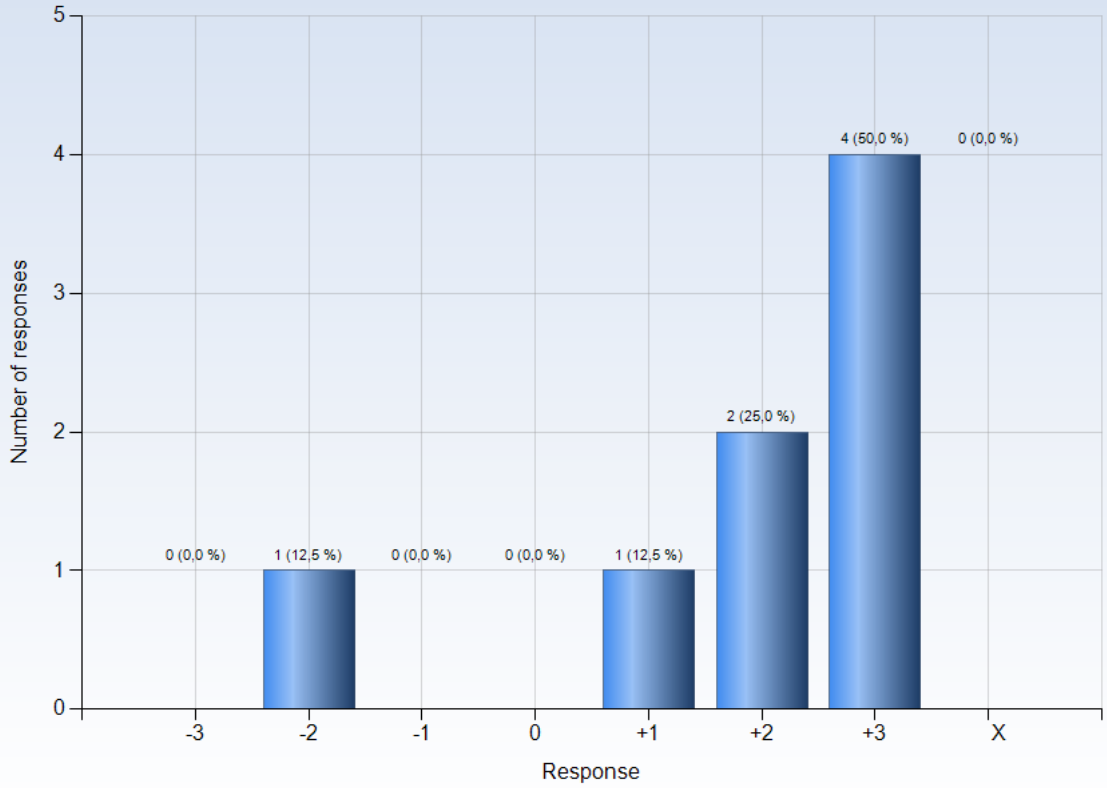

10. I was able to learn from concrete examples that I could relate to
Number of responses
Response
0 (0,0 %)
0 (0,0 %)
1 (11,1 %)
1 (11,1 %)
0 (0,0 %)
2 (22,2 %)
5 (55,6 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X

Comments

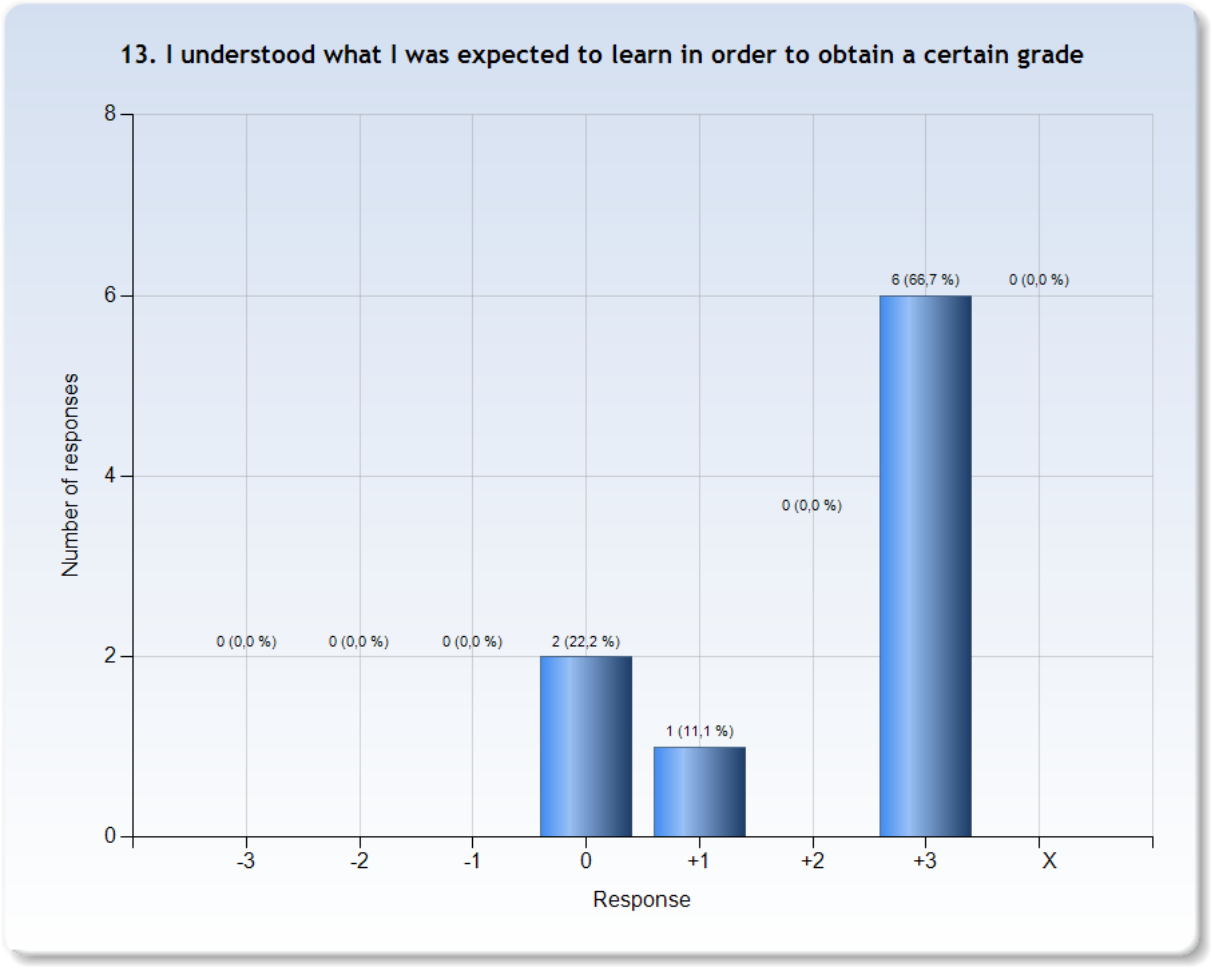

11. Understanding of key concepts had high priority
Number of responses
Response
0
1
2
3
4
5
-3
-2
-1
0
+1
+2
+3
X
0 (0,0 %)
0 (0,0 %)
2 (22,2 %)
0 (0,0 %)
1 (11,1 %)
2 (22,2 %)
4 (44,4 %)
0 (0,0 %)

Comments

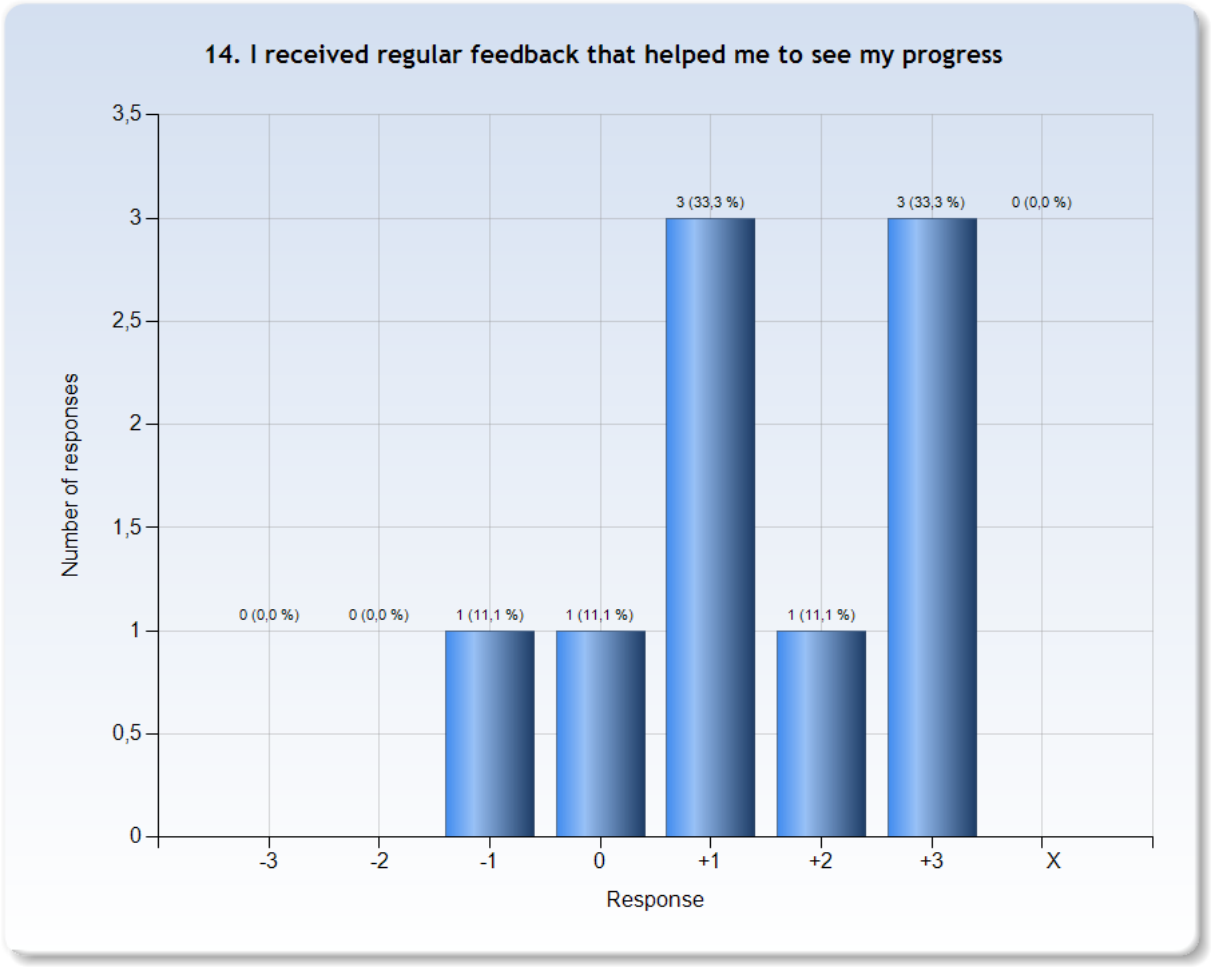
12. The course activities helped me to achieve the intended learning outcomes efficiently



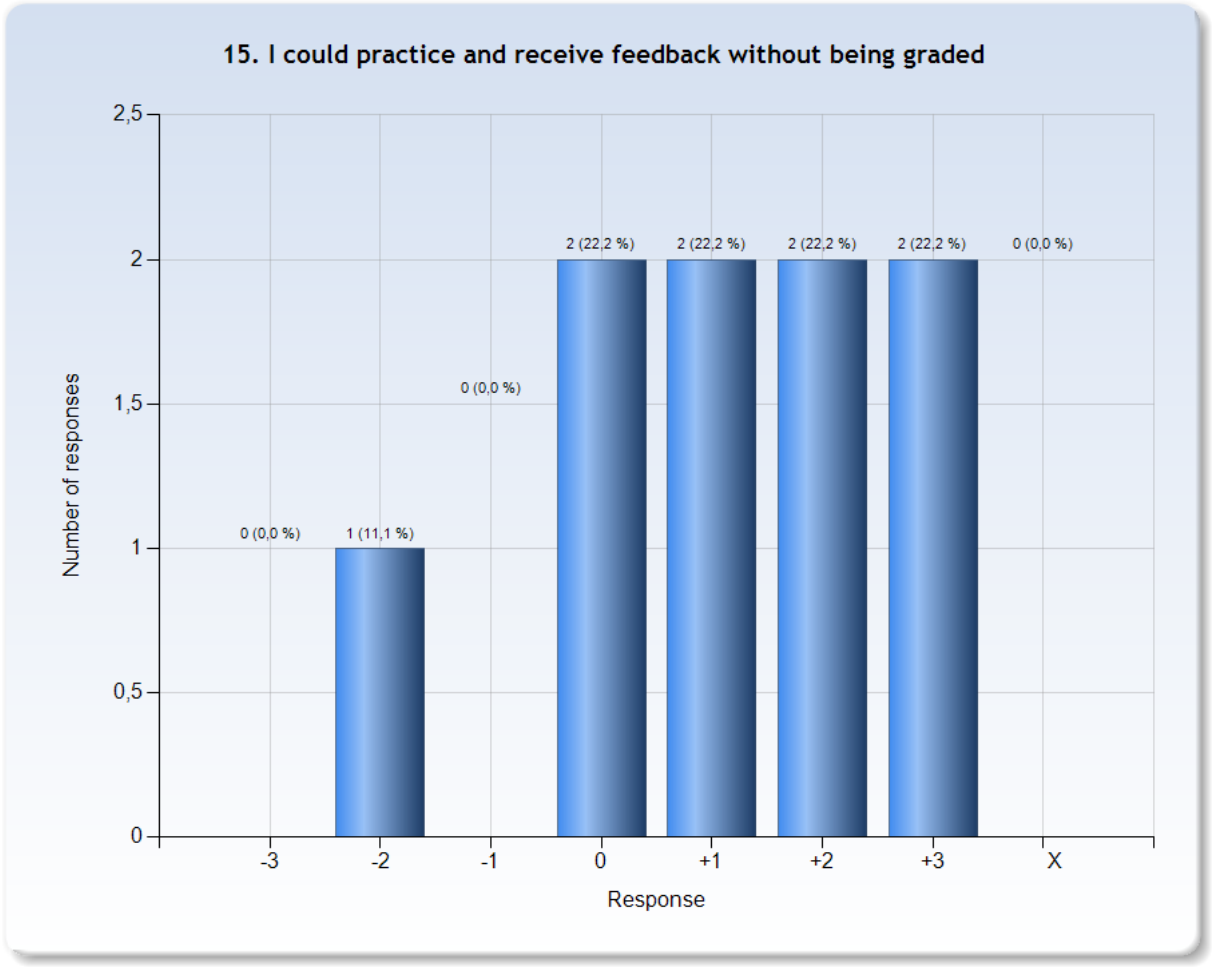
Comments


13. I understood what I was expected to learn in order to obtain a certain grade
Number of responses
8
6
4
2
0
0 (0,0 %)
0 (0,0 %)
0 (0,0 %)
2 (22,2 %)
1 (11,1 %)
0 (0,0 %)
6 (66,7 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X
Response

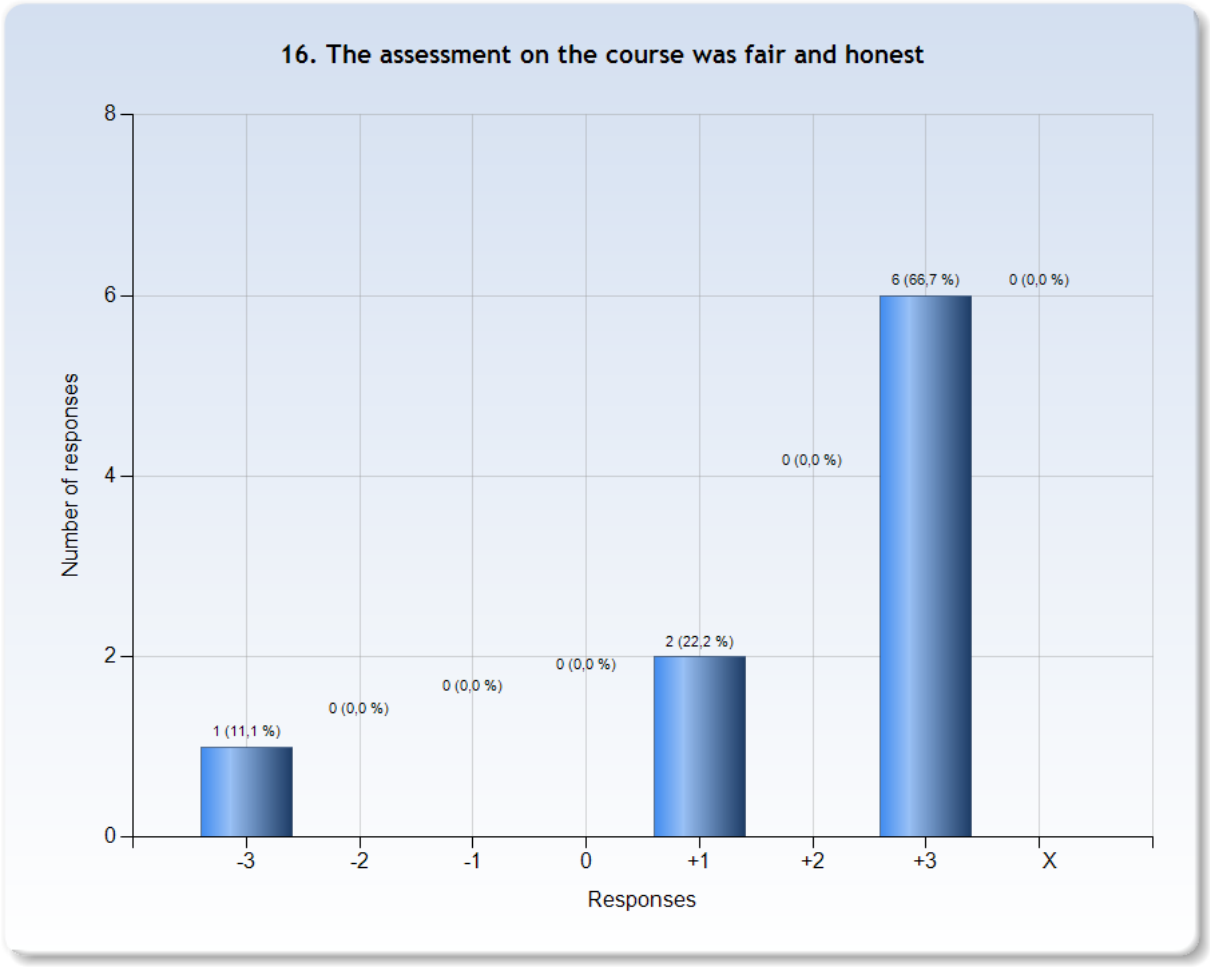
Comments


14. I received regular feedback that helped me to see my progress
Number of responses
3,5
3
2,5
2
1,5
1
0,5
0
0 (0,0 %)
0 (0,0 %)
1 (11,1 %)
1 (11,1 %)
3 (33,3 %)
1 (11,1 %)
3 (33,3 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X
Response

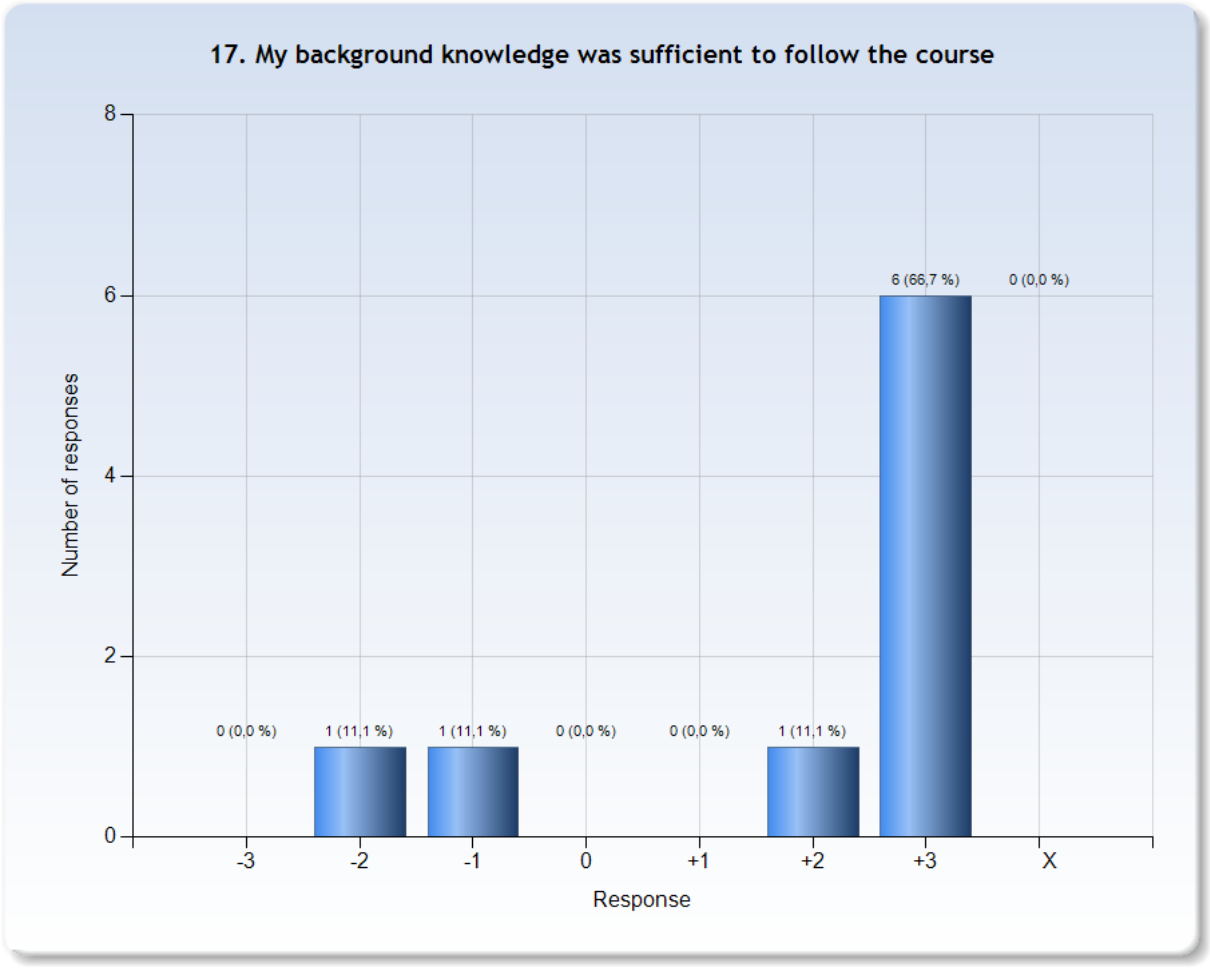
Comments


15. I could practice and receive feedback without being graded
Number of responses
2,5
2
1,5
1
0,5
0
0 (0,0 %)
1 (11,1 %)
0 (0,0 %)
2 (22,2 %)
2 (22,2 %)
2 (22,2 %)
2 (22,2 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X
Response

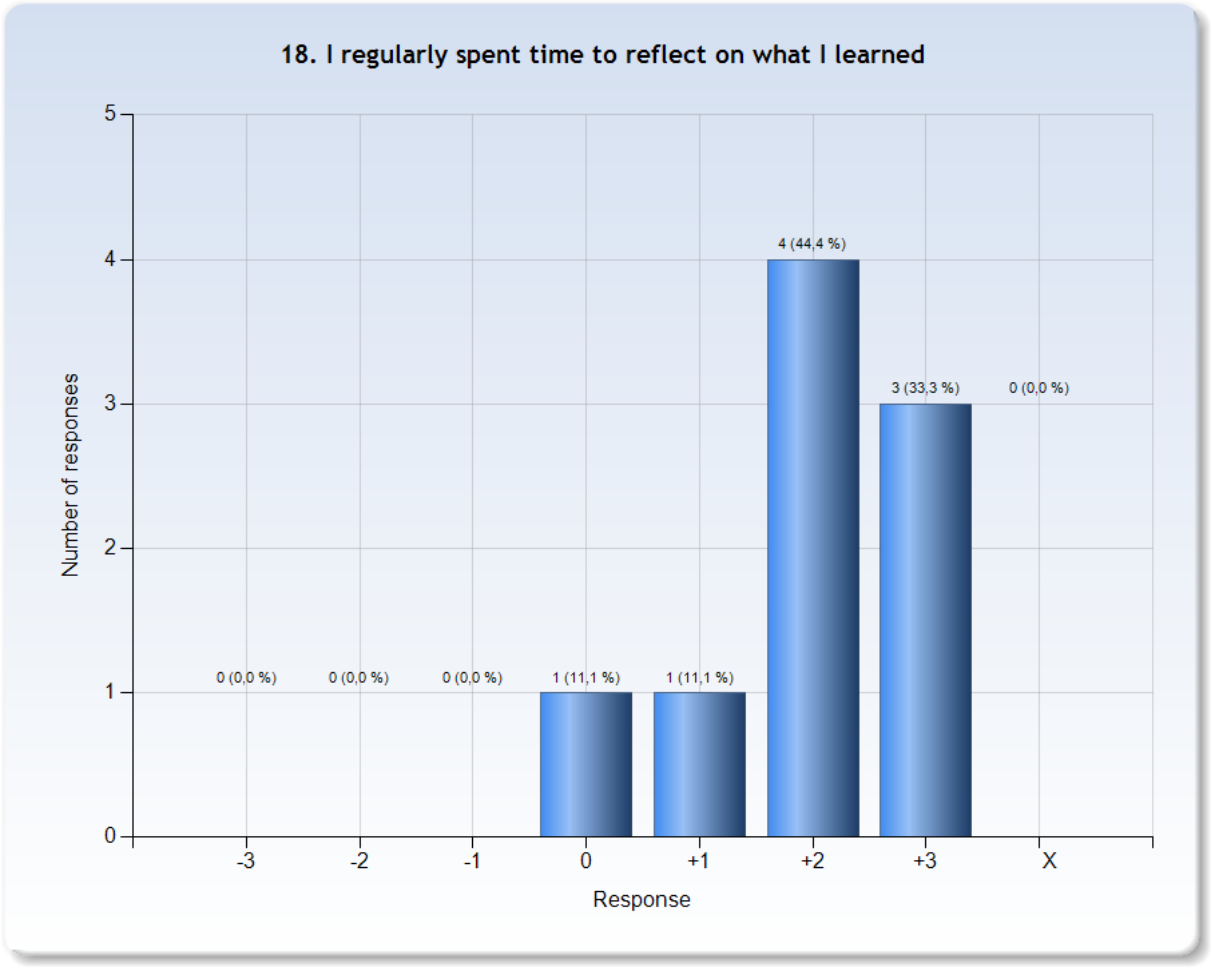
Comments


16. The assessment on the course was fair and honest
Number of responses
Responses
0
2
4
6
8
-3
-2
-1
0
+1
+2
+3
X
1 (11,1 %)
0 (0,0 %)
0 (0,0 %)
0 (0,0 %)
2 (22,2 %)
0 (0,0 %)
6 (66,7 %)
0 (0,0 %)

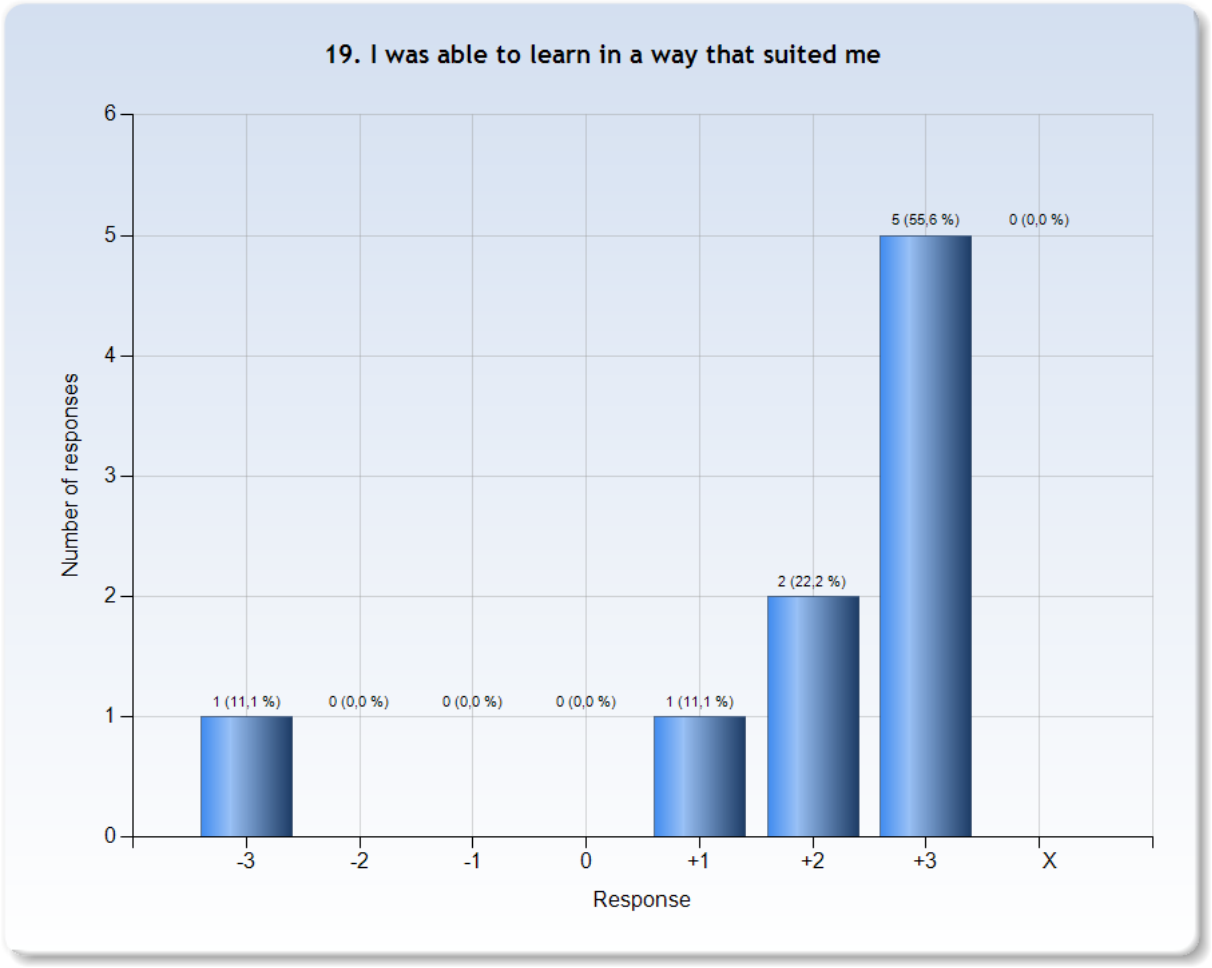
Comments


17. My background knowledge was sufficient to follow the course
Number of responses
8
6
4
2
0
0 (0,0 %)
1 (11,1 %)
1 (11,1 %)
0 (0,0 %)
0 (0,0 %)
1 (11,1 %)
6 (66,7 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X
Response

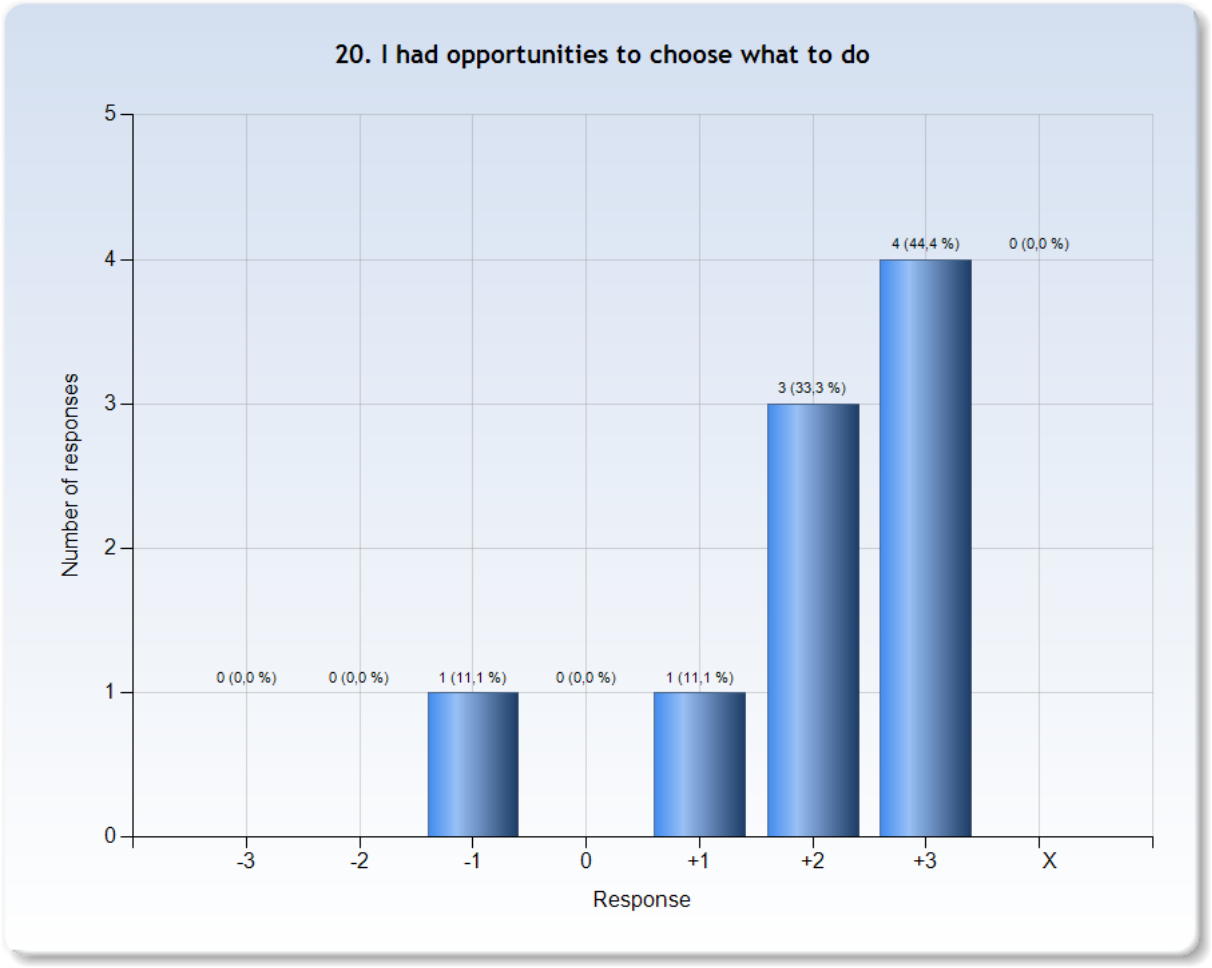
Comments


18. I regularly spent time to reflect on what I learned
Number of responses
Response
0
1
2
3
4
5
-3
-2
-1
0
+1
+2
+3
X
0 (0,0 %)
0 (0,0 %)
0 (0,0 %)
1 (11,1 %)
1 (11,1 %)
4 (44,4 %)
3 (33,3 %)
0 (0,0 %)

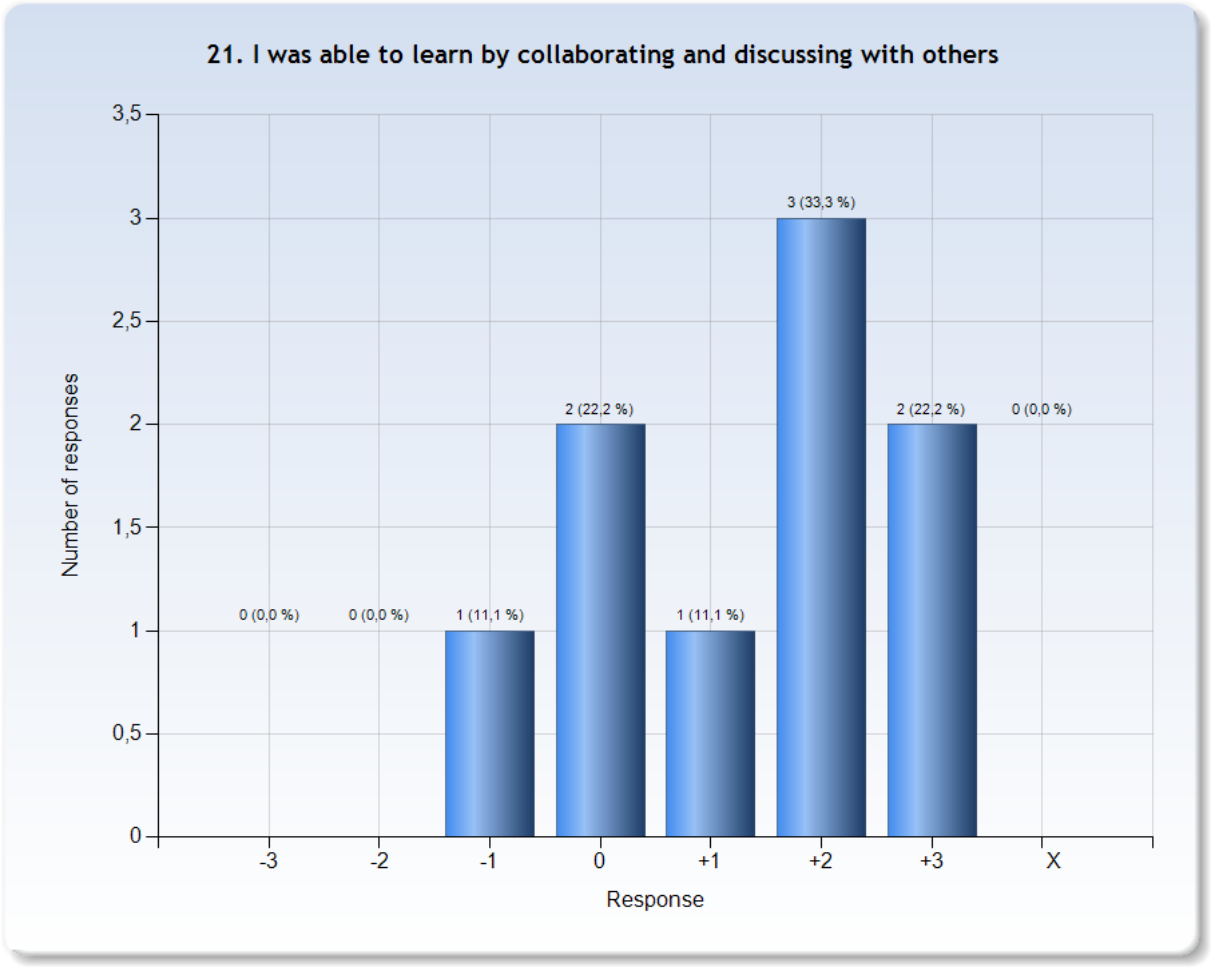
Comments


19. I was able to learn in a way that suited me
Number of responses
Response
0
1
2
3
4
5
6
-3
-2
-1
0
+1
+2
+3
X
1 (11,1 %)
0 (0,0 %)
0 (0,0 %)
0 (0,0 %)
1 (11,1 %)
2 (22,2 %)
5 (55,6 %)
0 (0,0 %)

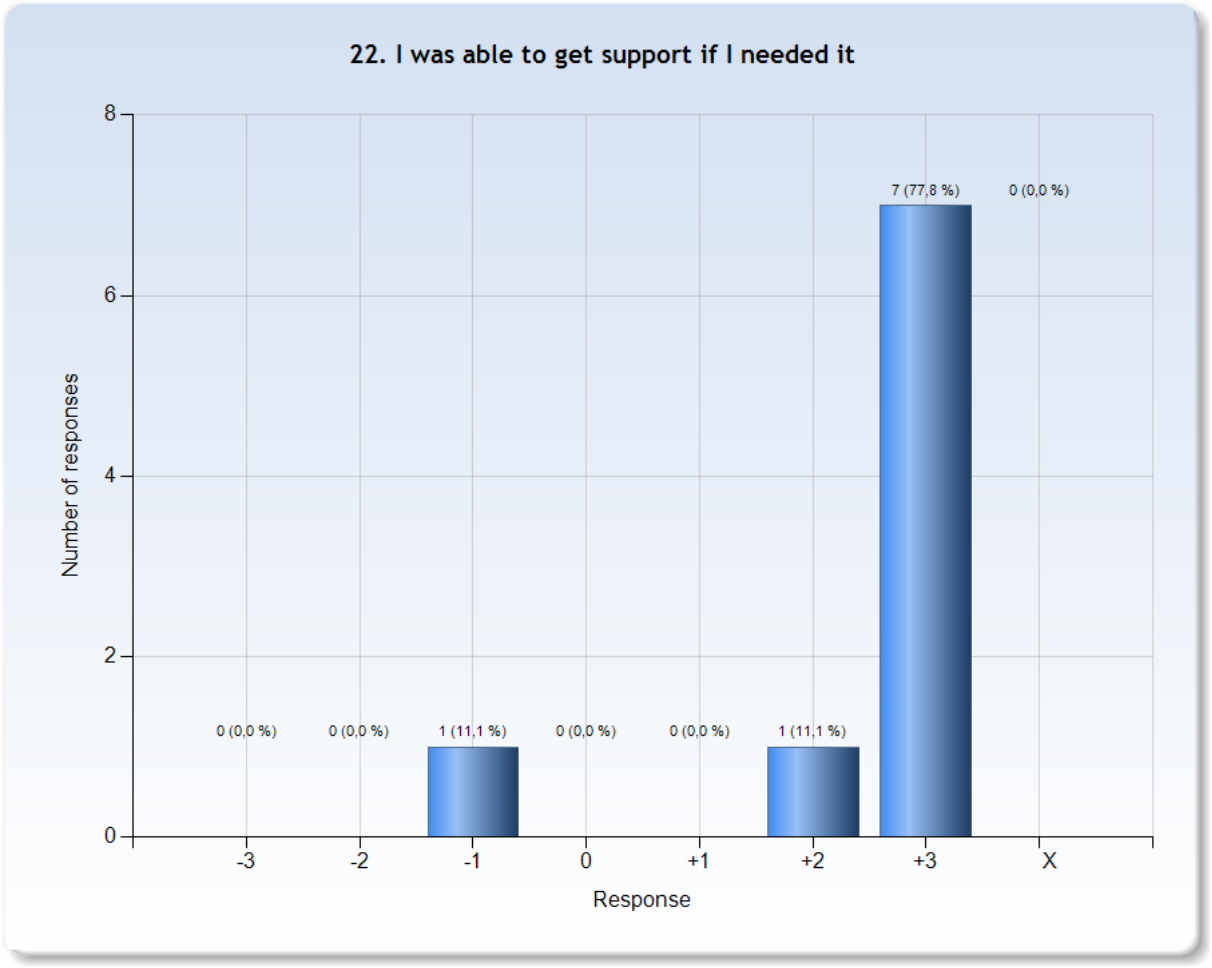
Comments


20. I had opportunities to choose what to do
Number of responses
Response
0
1
2
3
4
5
-3
-2
-1
0
+1
+2
+3
X
0 (0,0 %)
0 (0,0 %)
1 (11,1 %)
0 (0,0 %)
1 (11,1 %)
3 (33,3 %)
4 (44,4 %)
0 (0,0 %)

Comments


21. I was able to learn by collaborating and discussing with others
Number of responses
3,5
3
2,5
2
1,5
1
0,5
0
0 (0,0 %)
0 (0,0 %)
1 (11,1 %)
2 (22,2 %)
1 (11,1 %)
3 (33,3 %)
2 (22,2 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X
Response

Comments


22. I was able to get support if I needed it
Number of responses
Response
0 (0,0 %)
0 (0,0 %)
1 (11,1 %)
0 (0,0 %)
0 (0,0 %)
1 (11,1 %)
7 (77,8 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X

Comments

SF2822 Applied Nonlinear Optimization, 7.5hp, 2017/2018

Instructor and examiner

Anders Forsgren (andersf@kth.se), room 3533, Lindstedtsv. 25, tel 790 71 27.
Office hours: Monday 11-12. (Or by agreement.)

Exercise leader and project leader

Axel Ringh (aringh@kth.se), room 3734, Lindstedtsv. 25, tel. 790 66 59.
Office hours: By agreement.

Course material

- *Linear and Nonlinear Optimization*, second edition, by I. Griva, S. G. Nash och A. Sofer, SIAM, 2009.
  (The book can be ordered from several places. Please note that you can become a SIAM member for free and obtain a discount at the SIAM bookstore.)
- *Exercises in applied nonlinear optimization, 2017/2018*. Available via Canvas.
- *Supplementary course material in applied nonlinear optimization, 2017/2018*. Available via Canvas.
- *Lecture notes in applied nonlinear optimization, 2017/2018*. Can be downloaded from this web page, see the schedule below. Also available via Canvas.
- *GAMS, A user's guide*. Available at the GAMS web site.
- *GAMS*. GAMS is installed in the KTH linux computer rooms. It may also be downloaded from the GAMS web site for use on a personal computer.
- Two project assignments that are handed out during the course, April 12 and April 26 respectively.

Additional notes that may be handed out during the course are also included.

Course goals

After completed course, the student should be able to:

- explain fundamental concepts of nonlinear programming;

- explain how fundamental methods for nonlinear programming work;
- illustrate how these methods work by solving small problems by hand calculations;
- starting from a suitably modified real problem, formulate a nonlinear program; make a model in a modeling language and solve the problem;
- analyze the solutions of the optimization problem solved, and present the analysis in writing as well as orally;
- interact with other students when modeling and analyzing the optimization problems.

Examination

The examination is in two parts, projects and final exam. To pass the course, the following is required:

- Pass project assignment 1, with presence at compulsory presentation lecture on Thursday April 26, and presence at the following dicussion session.
- Pass project assignment 2, with presence at compulsory presentation lecture on Wednesday May 16, and presence at the following dicussion session.
- Pass final exam. Please note that advance application for participation in examinations is compulsory according to KTH's rules. This is done via "My Pages" for master students and via a particular form for PhD students. More information can be found here.

Course registration

Due to the project based nature of this course, students must register no later than April 9. Registration is made by the students online following KTH standard procedures. PhD students are not able to register online but register via e-mail to Anders Forsgren.

Project assignments

The project assignments are performed in groups, where the instructor determines the division of groups. This division is changed between the two assignments. Assignment 1 is carried out using the modeling language GAMS. For project 2, there is a choice between a modeling assignment, to be carried out using GAMS, or a method assignment, to be carried out using Matlab. The project assignments *must* be carried out during the duration of the course and completed by the above mentioned presentation lectures. It is the responsibility of each student to allocate time so that the project group can meet and function. Presence at the presentation lectures is compulsory. For passing the projects, the following requirements must be fulfilled:

- No later than the night before the presentation lecture, each group must hand in a well-written report which describes the exercise and the group's suggestion for solving the exercise. Suitable word processor should be used. The report should be on a level suitable for another participant in the course who is not familiar with the group's specific problem.
- When handing in the report, each student should append an individual sheet with a brief self-assessment of his/her contribution to the project work, quantitatively as well as qualitatively.
- At the presentation lecture, all assignments will be presented and discussed. Each

student is expected to be able to present the assignment of his/her group. In particular, each student is expected to take part in the discussion. The presentation and discussion should be on a level such that students having had the same assignment can discuss, and students not having had the same assignment can understand the issues that have arisen and how they have been solved.
- Each group should make an appointment for a discussion session with the course leaders. There is no presentation at this session, but these sessions are in the form of a 15 minutes question session, one group at a time. There will be times available the days after the presentation session. One week prior to the presentation lecture, a list of available times for discussion sessions will be made available at Doodle, reachable from the course home page. Each group should sign up for a discussion session prior to the presentation lecture.
- Each participant in the course must contribute to the work of the group. Each group must solve their task independently. Discussion between the groups is encouraged, but each group must individually solve the assignments. It is *not* allowed to use solutions made by others in any form. If these rules are violated, disciplinary actions in accordance with the KTH regulations will be taken.

Each project assignment is awarded a grade which is either fail or pass with grading E, D, C, B and A. Here, the mathematical treatment of the problem as well as the report and the oral presentation or discussion is taken into account. Normally, the same grade is given to all members of a group.

Final exam

The final exam consists of five exercises and gives a maximum of 50 points. At the exam, the grades F, Fx, E, D, C, B and A are awarded. For a passing grade, normally at least 22 points are required. At the exam, in addidion to writing material, no other material is allowed at the exam. Normally, the grade limits are given by E (22-24), D (25-30), C (31-36), B (37-42) and A (43-50).

The grade Fx is normally given for 20 or 21 points on the final exam. An Fx grade may be converted to an E grade by a successful completion of two supplementary exercises, that the student must complete independently. One exercise among the theory exercises handed out during the course, and one exercise which is similar to one exercise of the exam. These exercises are selected by the instructor, individually for each student. Solutions have to be handed in to the instructor and also explained orally within three weeks of the date of notification of grades.

The final exam is given Thursday May 31, 8.00-13.00.

Final grade

By identitying A=7, B=6, C=5, D=4, E=3, the final grade is given as

round((grade on proj 1) + (grade on proj 2) + 2 * (grade on final exam)) / 4),

where the rounding is made to nearest larger integer in case of a tie.

Preliminary schedule

(Lecture notes are not yet available.)

"L" means lecture, "E" means exercise session, "P" means project sesstion.

Type	Day	Date	Time	Room	Subject
L1.	Tue	Mar 20	13-15	E51	Introduction. Nonlinear programming models. (pdf)
L2.	Wed	Mar 21	8-10	D34	Optimality conditions for linearly constrained problems. (pdf)
L3.	Thu	Mar 22	10-12	D34	Optimality conditions for nonlinearly constrained problems. (pdf)
E1.	Mon	Mar 26	15-17	V33	Optimality conditions.
L4.	Wed	Mar 28	8-10	D34	Unconstrained optimization. (pdf)
L5.	Thu	Mar 29	10-12	D34	Unconstrained optimization, cont. (pdf)
E2.	Mon	Apr 9	15-17	D34	Unconstrained optimization.
P1.	Wed	Apr 11	8-10	D34	Introduction to GAMS.
P2.	Thu	Apr 12	10-12		GAMS excercise session.
L6.	Mon	Apr 16	15-17	D34	Equality-constrained quadratic programming. (pdf)
E3.	Wed	Apr 18	8-10	D34	Equality-constrained quadratic programming.
L7.	Thu	Apr 19	10-12	D34	Inequality-constrained quadratic programming. (pdf)
L8.	Fri	Apr 20	13-15	D34	Inequality-constrained quadratic programming, cont. (pdf)
E4.	Mon	Apr 23	15-17	D34	Inequality-constrained quadratic programming.
L9.	Wed	Apr 25	8-10	D34	Sequential quadratic programming. (pdf)
P3.	Thu	Apr 26	10-12	D34	Presentation of project assignment 1.
E5.	Wed	May 2	8-10	D34	Sequential quadratic programming.
L10.	Fri	May 4	13-15	D34	Sequential quadratic programming, cont. Interior methods for nonlinear programming. (pdf)
L11.	Mon	May 7	15-17	D34	Interior methods for nonlinear programming, cont. (pdf)
E6.	Wed	May 9	8-10	D34	Interior methods for nonlinear programming.
L12.	Mon	May 14	15-17	D34	Semidefinite programming.
P4.	Wed	May 16	8-10	D34	Presentation of project assignment 2.
E7.	Thu	May 17	10-12	D34	Semidefinite programming.

E8.	Fri	May 18	13-15	V23	Selected topics.

Overview of course contents

- **Unconstrained optimization**
  Fundamental theory, in particular optimality conditions.
  Linesearch algorithms, steepest descent, Newton's method.
  Conjugate directions and the conjugate gradient method.
  Quasi-Newton methods.
  (Chapters 11, 12.1-12.3 and 13.1-13.2 in Griva, Nash and Sofer.)
- **Constrained nonlinear optimization**
  Fundamental theory, optimality conditions, Lagrange multipliers and sensitivity analysis.
  Quadratic programming.
  Primal methods, in particular active-set methods.
  Penalty and barrier methods, in particular primal-dual interior methods.
  Dulal methods, local duality, separable problems.
  Lagrange methods, in particular sequential quadratic programming.
  (Chapters 3, 14.1-14.7, 14.8.1, 15.1-15.5, 16.1-16.3 and 16.7 in Griva, Nash and Sofer.)
- **Semidefinite programming**
  Fundamental theory.
  (Chapter 16.8 in Griva, Nash and Sofer. Separate article in the supplementary course material. Fundamental concepts only.)

Welcome to the course!

Course web page: http://www.math.kth.se/optsyst/grundutbildning/kurser/SF2822/.

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