KTH Information and Communication Technology

2 February 2016

Course analysis for:

Methods and Instruments of Analysis (IH2652), 7.5 hp
Compulsory course for the KTH Master's program in Nanotechnology (TNTEM)
26 registered students

Material Characterization for Electronics and Photonics (IH3606), 10.5 hp
PhD course for the ICT and Physics doctoral programs
8 registered students

Course responsible: Mattias Hammar, hammar@kth.se

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Appendices

1. Changes implemented since last course round

This was my first year as responsible for this course and it was thereby somewhat refurbished, partly since it wasn't fully documented regarding its previous content. Based on the given lectures, the course content has changed according to Table 1. However, it should also be noted that since there was no literature or detailed content specified for the previous academic year it is not fully clear to what extent the course has changed topic-wise. The laborations were maintained in their previous shapes although new instructions were written for the SPM, SEM and XRD labs. In this context it was noted that both the SPM and XRD labs have significant overlap with other compulsory courses on the Nanotechnology program (IH2654 and IM2660, respectively).

Topics	Academic year 2014/2015 [hours]	Academic year 2015/16 [hours]
X-ray diffraction analysis (XRD)	6	2
Electron Microscopy (SEM/TEM)	6	2
Carrier mobility measurements	4	
Scanning Probe Microscopy (SPM)	4	4
Rutherford Backscattering Spectrometry (RBS)	2	2
Secondary Ion Mass Spectrometry (SIMS)	2	2
Optical methods and properties	2	2
Electrical methods and properties		2
Electron spectroscopies		2
X-ray absorption spectroscopy		2
Tutorial session	2	2
RBS laboration	3	3
SPM laboration	4	4
SEM laboration	4	4
XRD laboration	4	4

Table 1. Distributed lecture hours on different topics in the course during the academic years 2014/15 and 2015/16. The lectures on SPM, RBS and optical methods were lectured by the same teacher both years while remaining lectures had new lecturers. The actual content may thereby have varied significantly between the years. The tutorial session was basically a rehearsal of the main course content including a review of old exam problems.

2. Course design

The course is quite traditional in design, consisting of lectures on the basic topics, one tutorial-style lecture, four laborations and a written exam. The laborations were distributed during the course such that the corresponding theory already had been covered in the lectures. The written exam focused on principles, qualitative descriptions and phenomenology rather than quantitative elaborations, the intention being to reward overall understanding.

3. Student workload according to survey

Being a 7.5-credit course over one period the expected workload should be around 20 hours per week. Only two students out of the 13 answering the survey indicated such an effort whereas the majority of students indicated significantly less, e.g. 6/13 where in the 4-9 hours regimes. Considering that this is a rather work-intensive course with lectures, laborations and report writings such low efforts should be considered under-critical and may partly explain the overall poor performance on the written exam.

4. Student results

The results on the exam were below all expectations. The details can be found in appendices 3 and 4. Only 5 out of 20 passed IH2652, with additional two students receiving an Fx grade with the option to upgrade to an E. The Ph.D. students on the IH3606 course scored better (averaging 17.5/30 as compared to 8.9/30 for the IH2652 students) and 4 out of 6 would have made it with similar threshold as for the IH2652 course. However, the threshold is higher for IH3606, and only 2 out of 6 Ph.D. students passed the exam. Notably, this is significantly worse that previous results on this course; see Appendix 4, with the majority of students getting the A grade and no student being failed during the time period 2009-2014.

5. Analysis of the survey

The course survey with corresponding answers from 13 out of 26 registered students is found in Appendix 5. Since the survey was distributed after the final exam it should have been quite clear to most of the students while filling it out that they were rather far from fulfilling the learning objectives as defined by the exam, and it would be of particular interest to see how this is reflected in the survey. However, the survey doesn't provide too much insight regarding this although there are some indications and opinions to consider:

- As previously noted, the student's efforts in terms of hours per week devoted to the course were in average far below expectation and presumably insufficient.
- Several students expressed the opinion that the amount of material to study was overwhelming and/or insufficiently specified (comments and replies to statement 13)
- Some students suggested that the lectures should have a better focus on the course core content (comments)
- Some students indicated insufficient (or too irregular) feedback to monitor progress (statement 14)
- Several students suggested more tutorial sessions (comments)
- Some students also indicated that the exam in some sense was too difficult or had an erroneous or unexpected focus (comments)

Of particular relevance here is probably that the examiner was new and that the exam was different from old exams given in the course. It can also be noted that bullets one and two appears to be in conflict with each other. I can appreciate some of these opinions and I believe that there are several measures that can be taken to improve the situation, see below.

6. Answers to open questions in the survey

Some summaries or selected replies with my own comments:

<u>What was the best aspect of the course?</u>
The overview character of the course, addressing several analysis techniques, was appreciated and in specific the lab parts with hands-on possibilities.
<u>What would you suggest to improve?</u>

- "The exam paper was too hard to score. It is a test of how much you have memorised not about concepts. If the students missed out studying the part in the book, he/she cannot get any points as he/she did not memorise them. Should test

more on the concepts instead of picking small topics that students might miss out studying."

My comment: *I don't agree on this. The exam was all about understanding, concepts and phenomenology; see Appendix 3. Some amount of "memorizing" is obviously unavoidable since the course deals with a range of different analysis techniques that will be new to the students both regarding instrumentation and underlying operating principles – you simply need to learn how things work – but I don't understand what would be examples of "picking small topics" in this exam. Either you understand, e.g., the concept of diffraction and can state Bragg's law and explain the Ewald construction and forbidden reflection, or you don't, but this is not "memorizing" in the sense that you store something in your brain without understanding it. Similarly you should be able to explain the operation of an AFM, the imaging modes of a TEM, the setup of PL measurement, the methodology to measure sheet and contact resistances, chemical shifts in XPS and the overall concepts of EXAFS and XANES, without the need to memorize certain details. If you are familiar with the concepts and understand them, you will be able to recapitulate them.*

- "This course is huge and widely distributed, that should be focused."
- "…to have less lectures on not totally related subjects and analysis methods and more tutorial sessions on practical work on the given subjects"
- "Should have tutorial sessions as it will help to strengthen the knowledge learned by working on some examples."
- "…recommend hosting of tutorials for those parts of the course not connected to any lab sessions, mostly to help the students make the deeper connections."
- "… to have less lectures on not totally related subjects and analysis methods and more tutorial sessions on practical work on the given subjects"

  My comment: *The course content and lectures can be better focused. This is a bit of a trade-off to invite lecturers that are experts on the topics and might have a tendency to expand towards novelties. In a sense the hottest research topics should be worthwhile mentioning in a course like this, but that will obviously to some extent obscure the main content. I also agree that more tutorial sessions probably would be helpful.*

- "The material intended for the exam could have been better specified. The literature regarding the topics covered was extensive and required a lot of work to get through."; "Using parts of 4 different books for the course becomes a little messy."

  My comment: *The reading material corresponds to nine book chapters with quite detailed reading instructions. This should not be unreasonable for this kind of course at this level. The need to include chapters from different books comes around due to the broad range of topics covered in the course.*

<u>Is there anything else you would like to add?</u>

- "They should have provided answers for the old exams which can help the students to revise much easier."
- "I had difficulty in the exams as i did not have any idea what kind of question pattern was going to come, so i prepared from the previous year's question paper. It did not help at all, as the previous year's question a lot of the formulas and the values were given to solve the questions, i expected that but we were given no

formulas or values. So it was difficult for me to solve it. If i had known we would be given nothing i would have spent extra time in preparing for them."

My comment: *There seems to be a fixation with old exams, and just preparing from the previous year's questions would appear to be a high-risk strategy, especially considering that there was a new examiner and that I several times also pointed out, on lectures and on the course web, that the new exam might be quite different.*

7. Comments from the students during a discussion session in the final lecture

Three comments came up during this discussion:

- More tutorials like the final lecture distributed during the course would be useful
- The XRD lab was appreciated despite the fact that a very similar lab on the very same instrument was part of the solid state physics course (IM2660) which is also compulsory on the Nanotechnology program (TNTEM) and which is given in the preceding period. The reason for this was stated as this lab being better organized and thereby allows for more hands-on by the students and thereby a better understanding.

  My comment: Another reason for the better understanding might simply be that this was the second time they were exposed to basically the same thing

- The reading list should be made available at an earlier stage in the course

  My comment: The reading list was available from the outset of the course but it was narrowed down at the final lecture (one month before the exam) and some supplementary material was added by the lecturers during the course

8. Priority course development

- The lectures should be better focused on the basic content, thus avoiding too much novelties and front-line research topics. They should also be designed for better overlap with the course literature.
- The overall number of lectures should be reduced slightly and replaced by tutorials sessions giving some examples of the techniques and their interpretations. The SPM lecture can be reduced from four to two hours and the x-ray absorption spectroscopy lecture is omitted.
- Some special topics can be lumped into other lectures or possibly skipped altogether. One example regards x-ray absorption spectroscopy that can be treated in conjunction with the electron spectroscopy lecture where synchrotron radiation studies are discussed.
- Two more tutorial sessions will be included
- I will do more of the teaching myself, at least the SPM lecture and the extra two tutorial sessions, to get a better control and continuity during the course
- The XRD lab should possibly adjusted for reduced overlap with the corresponding lab given in the solid state physics course (IM2660)

9. Other information

An overall discussion and refinement of the Nanotechnology program is ongoing. This may result in slight modifications of this course from a focus primarily related to thin films and microelectronics towards a more general focus of topics relevant to a wider field of nanotechnology.

Appendix 1. Course schedule fall 2015

Date	Time	Venue	Title	Lecturer	Literature
16/11	10-12	M36	X-ray diffraction (XRD)	Mattias Hammar	[1] ch. 7; [2] ch. 2
18/11	13-15	V11	Scanning Probe Microscopy (SPM) 1	Anand Srinivasan	[1] ch. 14; [2] ch. 5
23/11	10-12	V01	Scanning Probe Microscopy (SPM) 2	Anand Srinivasan	
24/11	13-15	E32	Electron Microscopy (SEM/TEM)	Mattias Hammar	[1] ch. 8; [2] chs. 3, 4
25/11	13-17	Kista	Laboration 1		
30/11	8-12	Kista	Laboration 2		
1/12	13-15	M33	Rutherford Backscattering RBS)	Anders Hallén	[1] chs. 2,3
2/12	13-15	V11	Optical methods and properties	Ilya Sytjugov	[2] ch. 9; [3]
4/12	8-12	Kista	Laboration 3		
7/12	8-12	Kista	Laboration 4		
8/12	13-15	M35	Electrical methods and properties	Gunnar Malm	[4]
9/12	13-15	V01	Electron spectroscopies	Jonas Weissenridder	[1] chs. 10, 12; [2] ch. 7
11/12	8-12	Kista	Laboration 5		
14/12	8-12	Kista	Laboration 6		
15/12	13-15	M33	X-ray absorption spectroscopy/EXAFS	Juris Purans	[1] ch. 9
16/12	13-15	Q22	Secondary Ion Mass Spectrometry (SIMS)	Mattias Hammar	[1] ch. 4; [2] ch. 8
17/12	14-17	Uppsala	RBS laboration		
18/12	10-12	E32	Summary, discussions	Mattias Hammar	
18/12	13-17	Kista	Laboration 7		
21/12	8-12	Kista	Laboration 8		
21/12	14-17	Uppsala	RBS laboration		
16/1	9-14	V23	Written exam		

Lab	Instructors	Location
XRD	Arash Salemi	Kista
	Carl-Reuterskiöld-Hedlund	
SEM	Ahmad Abedin	Kista
SPM	Ali Asadollahi	Kista
	Konstantinos Garidis	
RBS	Anders Hallen	Ångström Laboratory, Uppsala

Appendix 2. Course literature and reading instructions

Parts of four different books and one review paper were used during the course. Electronic copies of these are freely available from the KTH library:

[1] T.L. Alford, L.C. Feldman, J.W. Mayer, “Fundamentals of Nanoscale Film Analysis” Springer, 2007. E-book: http://link.springer.com/book/10.1007/978-0-387-29261-8/page/1

[2] Y. Lang, “Materials Characterization, Introduction to Microscopic and Spectroscopic Methods”, Wiley, 2013. E-book: http://onlinelibrary.wiley.com.focus.lib.kth.se/book/10.1002/9783527670772

[3] I. Pelant and J. Valenta, “Luminescence Spectroscopy of Semiconductors”, Oxford, 2012. E-book: http://www.oxfordscholarship.com/view/10.1093/acprof:oso/9780199588336.001.0001/acprof-9780199588336

[4] D.K. Schroder, “Semiconductor Material and Device Characterization, Third Edition”, Wiley, 2006. E-book: http://ieeexplore.ieee.org/xpl/bkabstractplus.jsp?bkn=5237928

[5] M.J. Deen, F. Pascal, "Electrical characterization of semiconductor materials and devices—review". E-book: http://link.springer.com/article/10.1007/s10854-006-0001-8

The lecture slides and some additional handouts were continuously posted on the course website.

Reading instructions

General
- Book chapters, articles, as specified
- Lecture notes where appropriate
- Laborations
- Focus on principles, qualitative descriptions and phenomenology

XRD
- Leng ch. 2, excl. 2.4
- Alford et al., ch. 7.5

SPM
- Leng ch. 5

SEM/TEM
- Leng chs. 3, 4

RBS
- Alford et al., ch. 3

Optical methods
- Pelant, chs. 1, 2

Electrical methods
- M. J. Deen and F. Pascal, J Mater Sci: Mater Electron (2006) 17:549–575; DOI 10.1007/s10854-006-0001-8

Electron spectroscopies
- Leng, ch. 7

X-ray absorption spectroscopy
- Alford et al., ch. 9

SIMS
- Leng ch. 8

Appendix 3: Exam 20160116

KTH Information and Communication Technology

Written exam:

Methods and Instruments of Analysis, IH2652
Material Characterization for Electronics and Photonics, IH3606

Saturday 2016-01-16, 09.00 - 14.00, Location: V23

Allowed aids: Standard-type calculator

Course responsible: Mattias Hammar, tel 08-7904375, e-mail: hammar@kth.se

The exam includes six questions, each of which can be awarded with up to five point. The maximum score on the exam is thus 30 points. The grades will be distributed roughly according to:

IH2652

F	Fx	E	D	C	B	A
<13	13	15	18	21	24	27

IH3606

Fail	Pass
<21	21

The results will be posted no later than Friday 2016-02-05.

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1. X-ray diffraction

a. State the diffraction condition from a crystalline material using Bragg's law and describe how it can be evaluated using the so-called Ewald construction. (1 p)

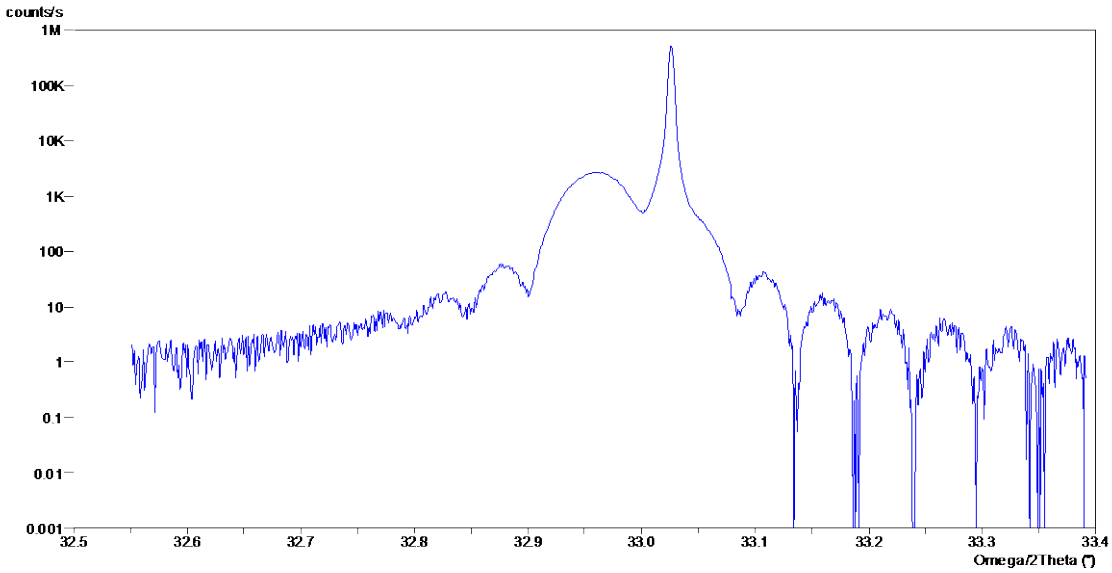
b. Why does a polycrystalline material give rise to a ring-like diffraction pattern (Debey rings)? (1 p)

c. What is the origin of "forbidden reflections" (structure factor = 0) in X-ray diffraction from a crystalline material? (1 p)

d. The below figure shows an high-resolution X-ray diffraction ω-2θ scan around the GaAs (004) reflection recorded on an epitaxial structure

where a thin layer of AlGaAs has been grown on a GaAs(001) substrate.

- Explain the observed features. What information about the structure can be extracted from them? (1 p)
- Make a rough estimate of the AlGaAs layer thickness. (1 p)



2. Microscopy

a. Make a schematic drawing of an atomic force microscope (AFM) and describe the main parts and operating principles, assuming tapping mode imaging. What is meant by amplitude and phase imaging in this context and what are the respective advantages (2 p)

b. Describe the following transmission electron microscopy (TEM) imaging modes:

- Bright-field imaging (1 p)
- Dark-field imaging (1 p)
- Weak-beam dark-field imaging (1 p)

3. Ion-beam analysis

A thin Ni film is deposited on a silicon substrate and annealed to form nickel silicide (NiSi). The structure is examined by Rutherford backscattering spectrometry (RBS) before and after the annealing. Describe the typical experimental conditions (incident ion type and energy, backscattering angle) and make a schematic drawing of the recorded RBS spectra. Explain the different features and their origins. What information can be extracted and what would be the procedure (described in qualitative terms) for this analysis? (5 p)

4. Optical spectroscopy

You want to characterize a sample by photoluminescence spectroscopy for which you need to build an appropriate setup. You have the following equipment at hand: An optical table, a laser source, a scanning monochromator, a photodetector, a chopper, a lock-in amplifier and a well-equipped cupboard with various optical components such as lenses, mirrors as well as suitable electrical connectors and cables. You also have a computer by which you can control and monitor the movement of the monochromator and record various synchronous electrical signals. You may assume that the laser source, photodetector and monochromator are suitable for the excitation and detection of the luminescence from this particular sample. Make a schematic drawing of the setup, indicate the beam paths (excitation and luminescence) and suggest how the data acquisition can be performed making use of the chopper and lock-in amplifier to suppress noise and various optical and/or electrical fluctuations. (5 p)

5. Electrical characterization

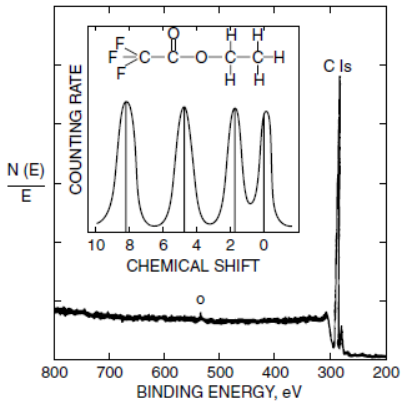
a. Explain and compare the two-point-probe, four-point-probe, van der Pauw and spreading resistance measurement techniques to assess the bulk resistivity of a semiconductor sample. Hall measurements can also provide the bulk resistivity of a semiconductor sample but this technique also provides some additional information; what? (3 p)

b. Explain and compare the two main characterization methods to assess contact resistance using Kelvin or transmission line (TLM) test structures. (2 p)

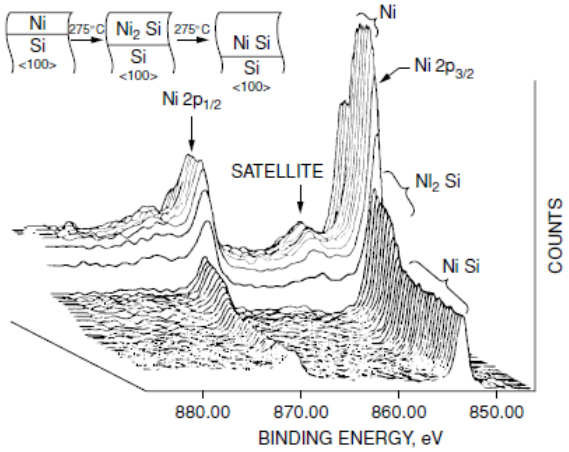
6. Electron and photon spectroscopy

a. The figures below show high-resolution X-ray photoelectrons spectroscopy (XPS) data from (*left*) ethyl trifluoroacetate ($C_4F_3O_2H_5$) and (*right*) a nickel-silicon bilayer under different stages of a thermally induced silicidation process. Explain the origin of the C 1*s* peak splitting (chemical shifts) for the $C_4F_3O_2H_5$ molecule and the changes in binding energy and intensity for the Ni 2*p* components during the silicidation. (3 p)

Appendix 3: Exam 20160116



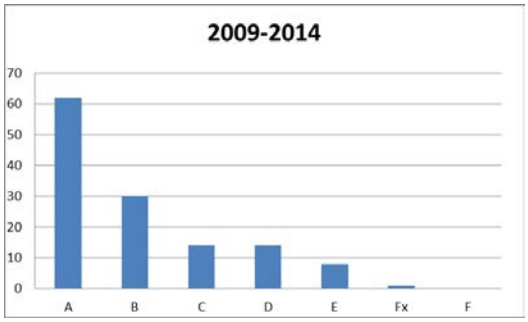
Carbon 1*s* chemical shifts in $C_4F_3O_2H_5$.

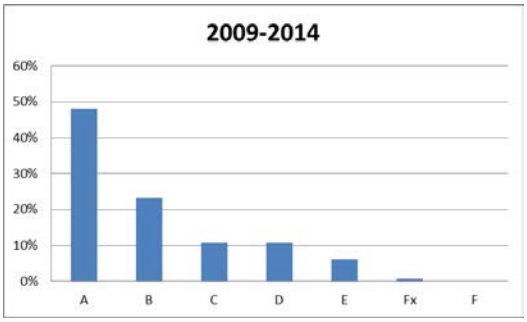


Three-dimensional plot of the Ni 2*p* XPS spectra. The z-axis (outwards the page) represents the time during heat treatment.

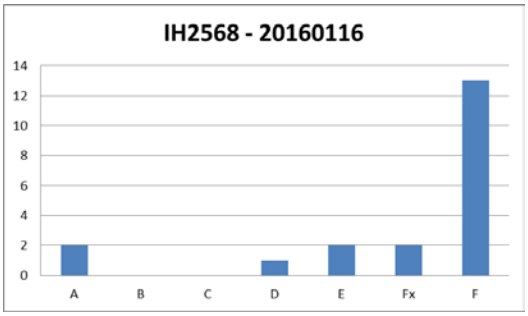
b. Describe the technique of Extended X-ray Absorption Fine Structure (EXAFS) spectroscopy. (2 p)
   - What are the experimental conditions?
   - What would a typical spectrum look like?
   - From what do the observed features in the spectrum originate and what information can be extracted from them?
   - How does this differ from X-ray Absorption Near-Edge Structure (XANES; sometimes called Near-Edge X-ray Absorption Fine Structure - NEXAFS)?

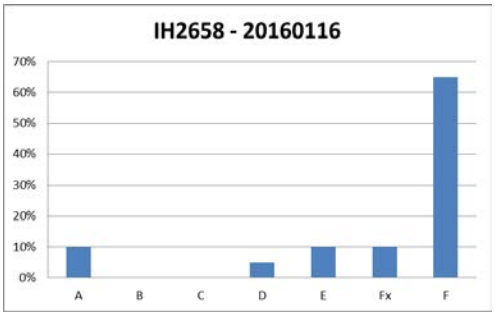
Appendix 4. Exam statistics 2009-2016





Summarized statistics in absolute numbers and percentage for all exams in IH2652 given during the academic years 2008/2009 through 2014/2015. The grading scale was: E=16, D=17-19, C=20-22, B=23-25 and A=26-30



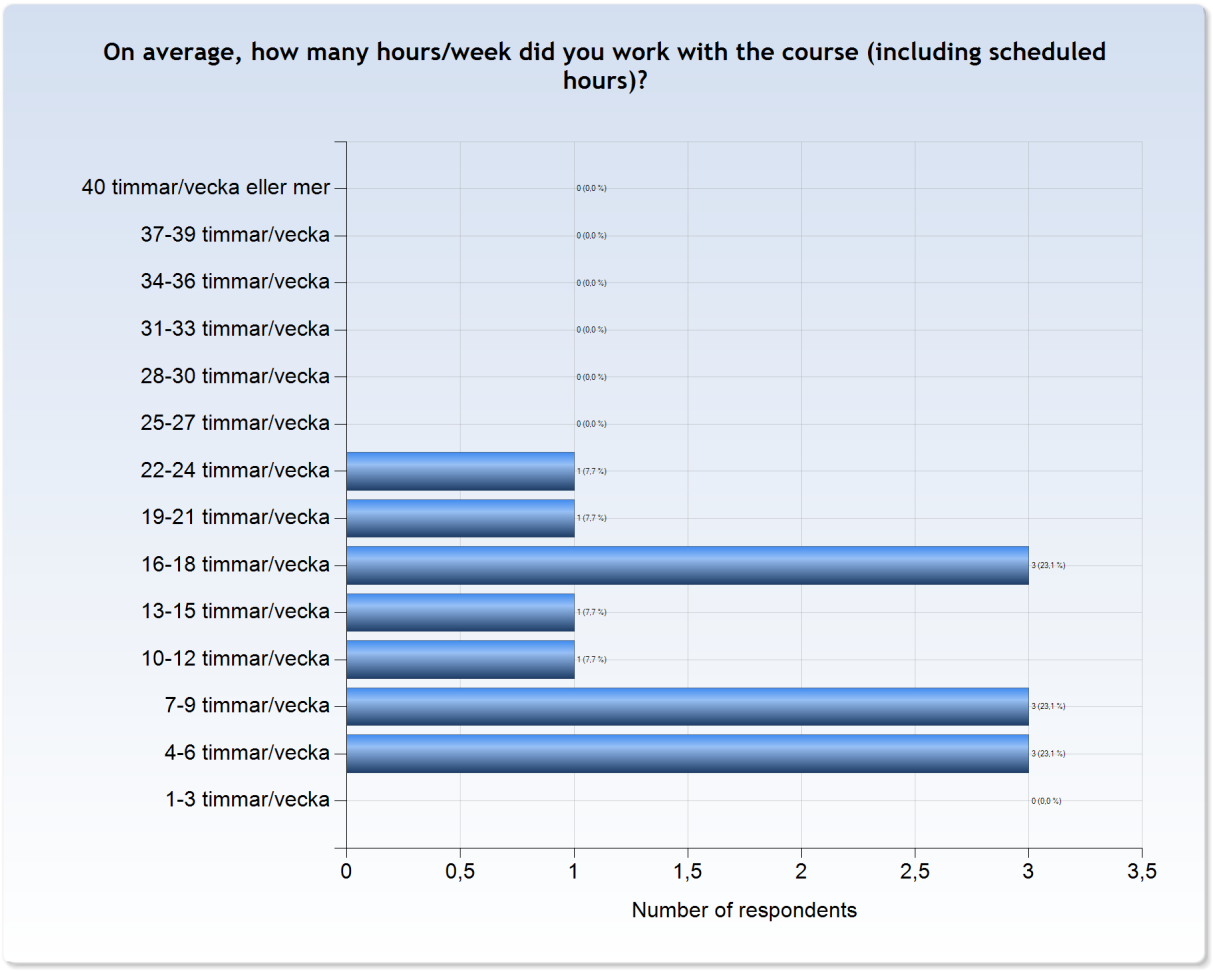


The distribution of grades in absolute numbers and percentage for the exam given in the present course round. The grading scale was adjusted by one step from [Fx≥13, E≥15, D≥18, C≥21, B≥24, A≥27] to [Fx≥11, E≥13, D≥15, C≥18, B≥21, A≥27] to somewhat compensate for the apparent increased level of difficulty as compared to previous years.

IH2652 - 2016-01-15

Antal respondenter: 26
Antal svar: 13
Svarsfrekvens: 50,00 %

ESTIMATED WORKLOAD



Comments

Comments (I worked: 4-6 timmar/vecka)
I took 3 courses at this periods, so I could not prepare and study enough.

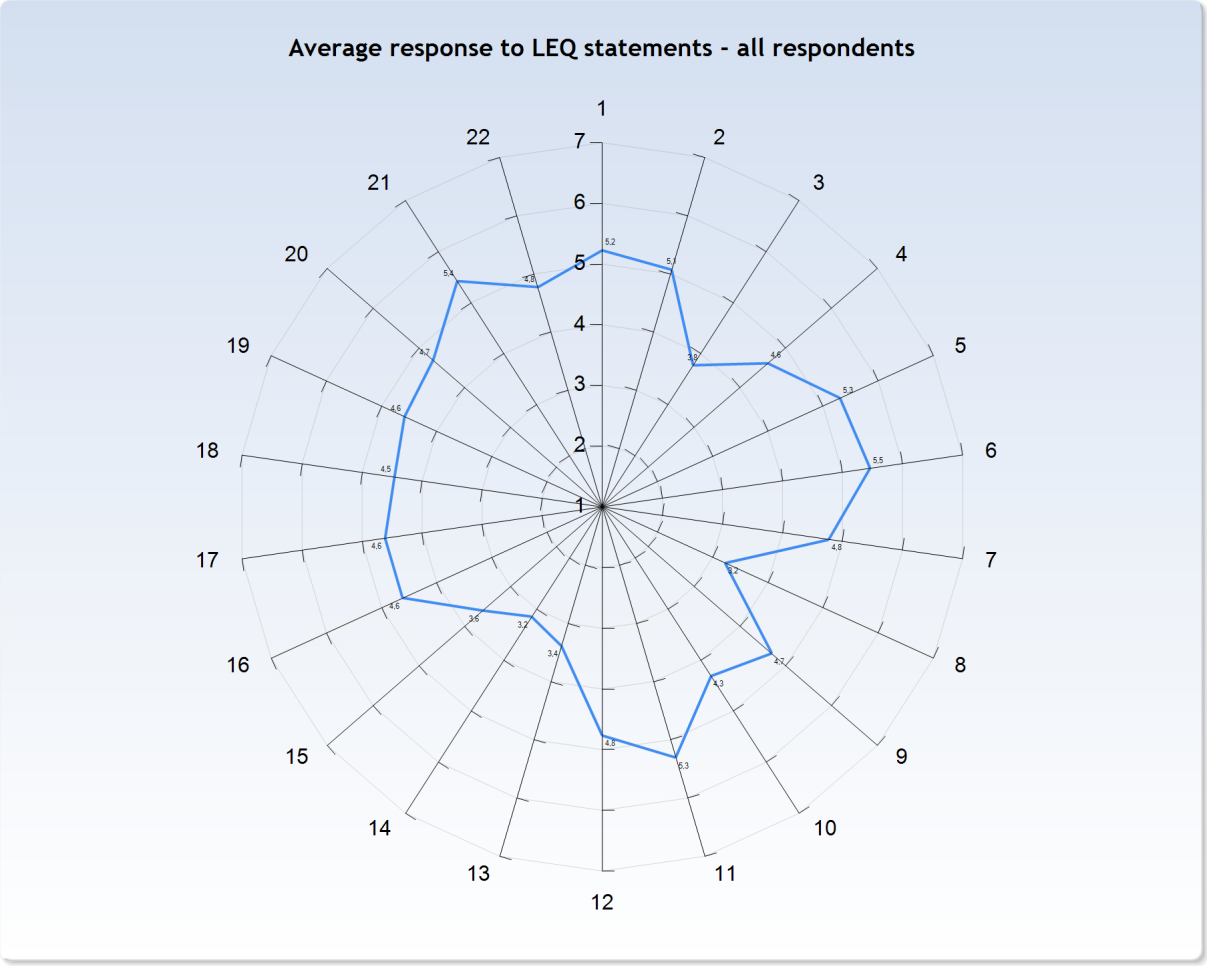
Comments (I worked: 16-18 timmar/vecka)
I did not study sufficiently during the first part of the course.
Most of that time doing laboratory reports

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 three respondents in order to appear in a diagram.



KTH Learning Experience Questionnaire v3.1.1

Meaningfulness - emotional level

Stimulating tasks
1. I worked with interesting issues

Exploration and own experience
2. I explored parts of the subject on my own
3. I could learn by trying out my own ideas

Challenge
4. The course was challenging in a stimulating way

Belonging
5. I felt togetherness with other course participants
6. The atmosphere in the course was open and inclusive

Comprehensibility - cognitive level

Clear goals and organization
7. The learning objectives helped me understand what I was expected to achieve
8. I understood how the course was organized and what I was expected to do

Understanding of subject matter
9. I understood what the teachers were talking about
10. I could learn from concrete examples that I was able to relate to
11. Understanding of key concepts was given high priority

Constructive alignment
12. The course activities helped me to reach the learning objectives efficiently
13. I understood what I was expected to learn in order to get a particular grade

Feedback and security
14. I regularly received feedback that helped me see my progress
15. I could practice and receive feedback without any grading being done
16. The assessment on the course was fair and honest

Manageability - instrumental level

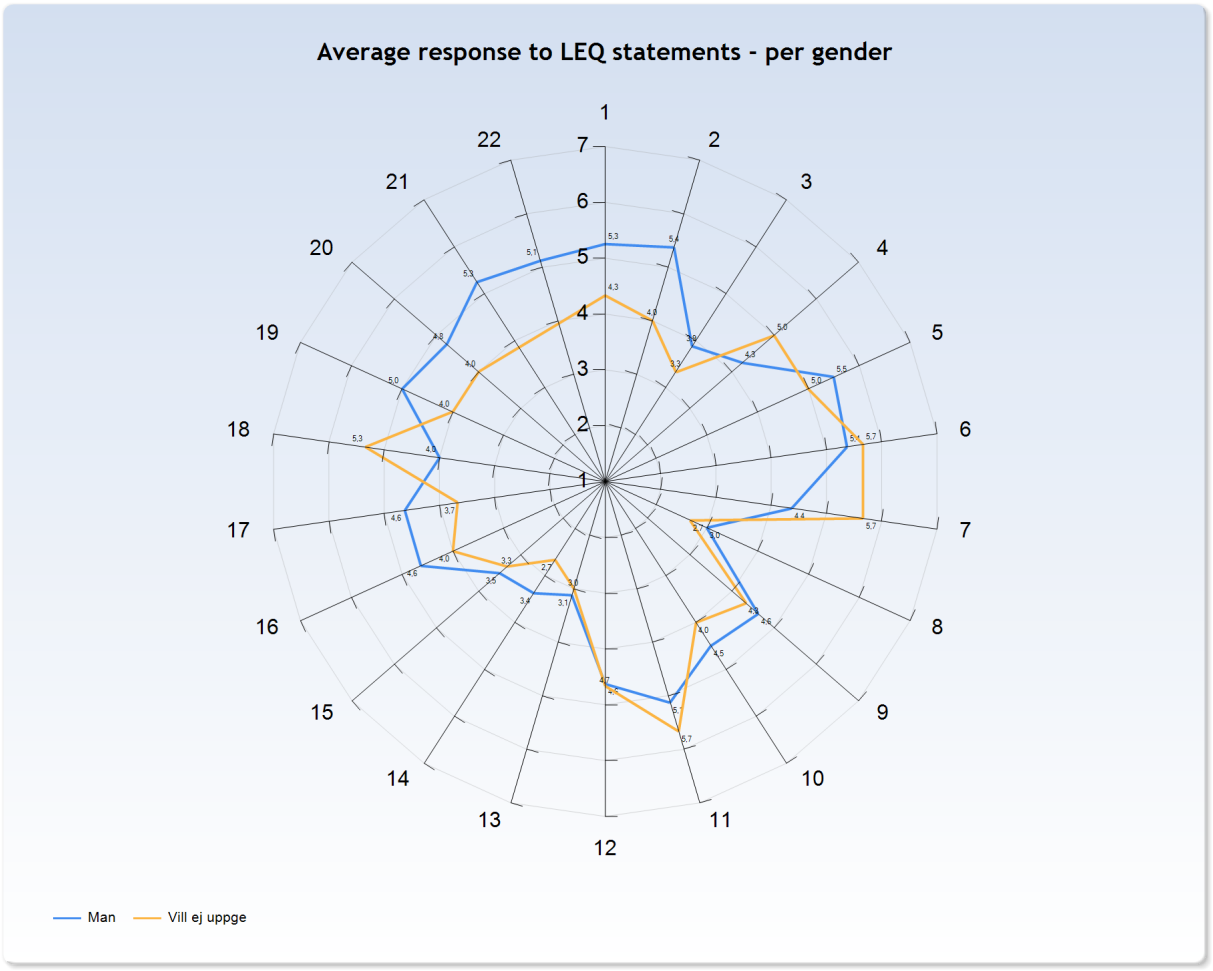
Sufficient background knowledge
17. My background knowledge was sufficient to follow the course

Time to reflect
18. I regularly spent time to reflect on what I learned

Variation and choices
19. I could learn in a way that suited me
20. I had opportunities to choose what I was going to do

Collaboration
21. I could learn by collaborating and discussing with others

Support
22. I could get support if I needed it


Average response to LEQ statements - per gender
1
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7
8
9
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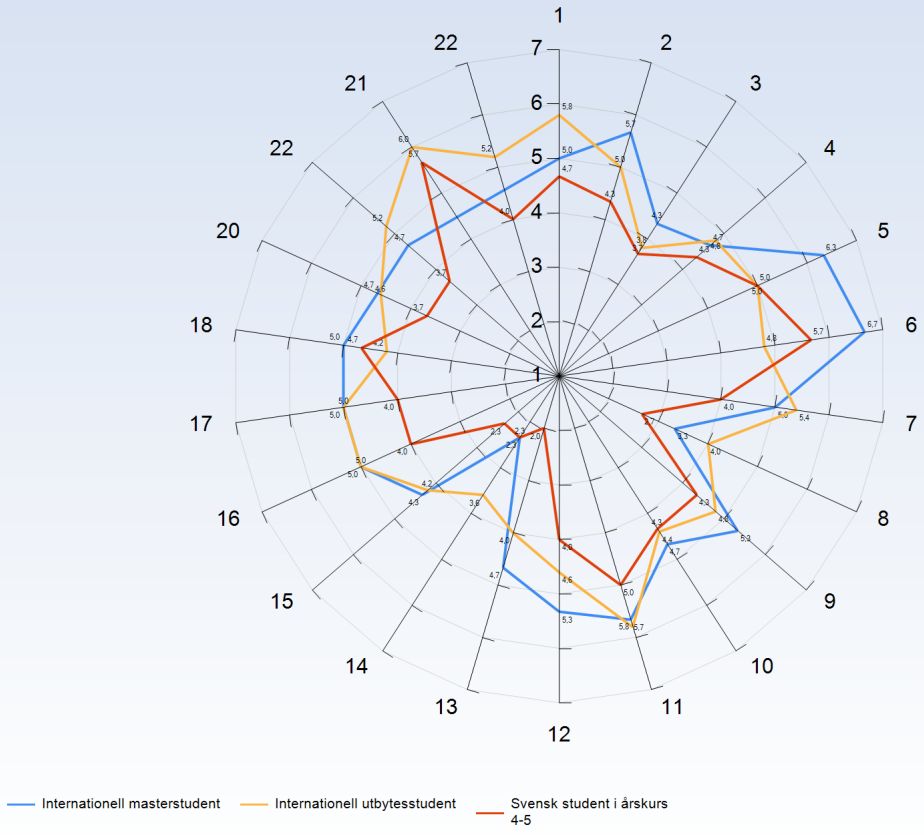
Comments

Average response to LEQ statements - per type of student



Internationell masterstudent
Internationell utbytesstudent
Svensk student i årskurs 4-5

Comments

GENERAL QUESTIONS

What was the best aspect of the course?

What was the best aspect of the course? (I worked: 4-6 timmar/vecka)
There are challenging and useful laboratory works in the course. It is practical and makes easy to understand the concept of instruments. Especially, in RBS laboratory, We needed to handle with analyzing software and it needs a lot of consideration to analyze the data. Such consideration might be directly used to actual experiments.
The labs help a lot in understanding the concept of the equipments
Laboratory sessions to apply knowledge learned from textbook

What was the best aspect of the course? (I worked: 7-9 timmar/vecka)
the best aspect was to get to know the different methods used to do experiments and that helps in research.
To learn different instrument techniques.

What was the best aspect of the course? (I worked: 10-12 timmar/vecka)
Definitely the laboratory exercises, they made the subject matter come alive in context and encouraged a deeper understanding of the processes involved.

What was the best aspect of the course? (I worked: 13-15 timmar/vecka)
Labs, getting feedback several times if needed.

What was the best aspect of the course? (I worked: 16-18 timmar/vecka)
The general overview of characterization methods commercially used and their application as well as consideration as to which method suits best in different scenarios. Interesting topics and inspiring laboratory work, especially with the visit to the Ångström Laboratory.
The laboratory sessions
labs

What was the best aspect of the course? (I worked: 19-21 timmar/vecka)
I did enjoy the labs.

What would you suggest to improve?

What would you suggest to improve? (I worked: 4-6 timmar/vecka)
The exam paper was too hard to score. It is a test of how much you have memorised not about concepts. If the students missed out studying the part in the book, he/she cannot get any points as he/she did not memorise them. Should test more on the concepts instead of picking small topics that students might miss out studying.
Should have tutorial sessions as it will help to strengthen the knowledge learned by working on some examples.

What would you suggest to improve? (I worked: 7-9 timmar/vecka)
This course is huge and widely distributed, that should be focused.
Give some assignments to do ourselves at home.

What would you suggest to improve? (I worked: 10-12 timmar/vecka)
Consistency of lecture quality. As of now, there are a lot of people involved and the quality if the presentations fluctuate heavily. Many of the slide collections used felt as if they were not designed for the course as they contained a lot that was skipped over by the respective lecturers. This gives the impression that the slides were made for another purpose and just used for this course due to laziness. Many of the slides would not even have been accepted at a student presentation due to unclear editing, to small fonts/images blending together and so on. One would expect higher quality for course material. Since only about half the course is represented during the labs, only that half really integrates pure theory with practical aspects due to the need for problem solving. For the parts NOT represented with labs, it is very hard to practice the calculatory parts since a very limited amount of exercises are present in the literature. I would recommend hosting of tutorials for those parts of the course not connected to any lab sessions, mostly to help the students make the deeper connections. Many of the questions for the non lab-related parts during the exam felt as if they were on a far too deep level to be achieved during the course. Many direct questions about the course organization were directly avoided by course representatives. Travel instructions provided for the visit to Uppsala were non existent which is a huge failure considering most of the involved students are part of an exchange and lack proper knowledge of how to get around. The planning of the exam also felt very last minute from conversations with the course responsible which begs the question if the people involved had actually decided on what to include in the course from the beginning. Not the general guidelines, those were quite well sectioned, but more how deep to go into the different subjects and how to structure the information in a good way.

What would you suggest to improve? (I worked: 13-15 timmar/vecka)
More specfic feedback on bad labreports (We got feedback "not enough") Example of old exam relevant to setup, example on HOW the exam would look.

What would you suggest to improve? (I worked: 16-18 timmar/vecka)
The layout of the course, especially since the participants in the course came from a varitey of different backgrounds within engineering. Some topics seemed especially hard for people with a particular educational background. The material intended for the exam could have been better specified. The literature regarding the topics covered was extensive and required a lot of work to get through.
To have a more structured course material. Also if possible, to have less lectures on not totally related subjects and analysis methods and more tutorial sessions on practical work on the given subjects
old exams

What would you suggest to improve? (I worked: 19-21 timmar/vecka)
Using parts of 4 different books for the course becomes a little messy.

What advice would you like to give to future course participants?

What advice would you like to give to future course participants? (I worked: 4-6 timmar/vecka)
Study all parts of the literature as this course is content heavy and more of memory work instead of concept.
-

What advice would you like to give to future course participants? (I worked: 7-9 timmar/vecka)
Go through the books thoroughly even though the course and the syllabus might seem huge. The presentations are not so helpful and you wont get the full understanding from them.
Start to study the first day as its a comprehensive course.

What advice would you like to give to future course participants? (I worked: 10-12 timmar/vecka)
Get access to the material quickly and request reading instructions early on since the potential amount of information in the course is massive.

What advice would you like to give to future course participants? (I worked: 13-15 timmar/vecka)
Concentrate on the areas you wn't have labs in.

What advice would you like to give to future course participants? (I worked: 16-18 timmar/vecka)
Make sure to study continuously and pay attention to details presented in the lectures. Enjoy the laboratory work!
Be ready to make consistent reports

Is there anything else you would like to add?

Is there anything else you would like to add? (I worked: 4-6 timmar/vecka)
They should have provided answers for the old exams which can help the students to revise much easier.
-

Is there anything else you would like to add? (I worked: 7-9 timmar/vecka)
I had difficulty in the exams as i did not have any idea what kind of question pattern was going to come, so i prepared from the previous year's question paper. It did not help at all, as the previous year's question a lot of the formulas and the values were given to solve the questions, i expected that but we were given no formulas or values. So it was difficult for me to solve it. If i had known we would be given nothing i would have spent extra time in preparing for them.
No thanks.

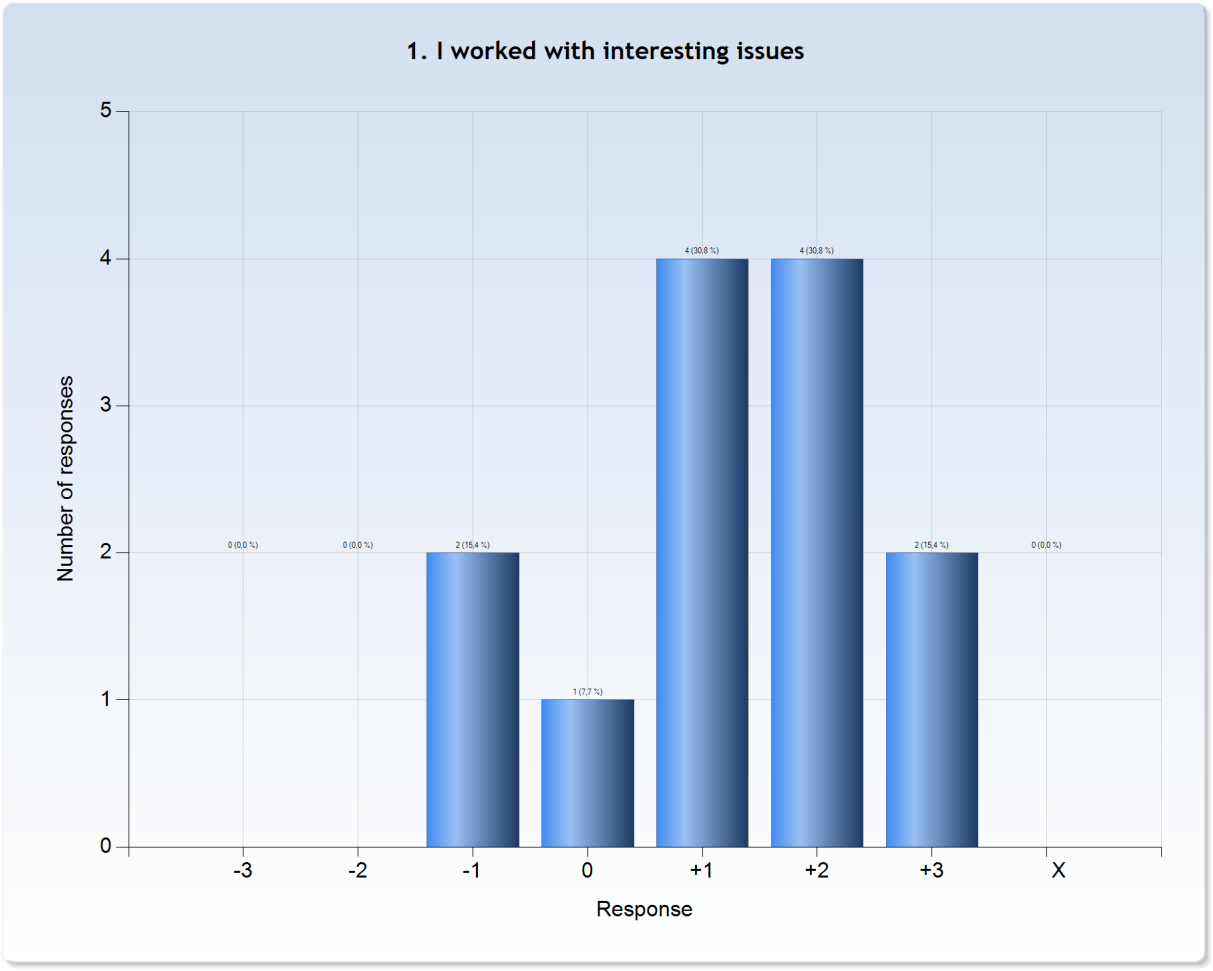
SPECIFIC QUESTIONS

RESPONSE DATA

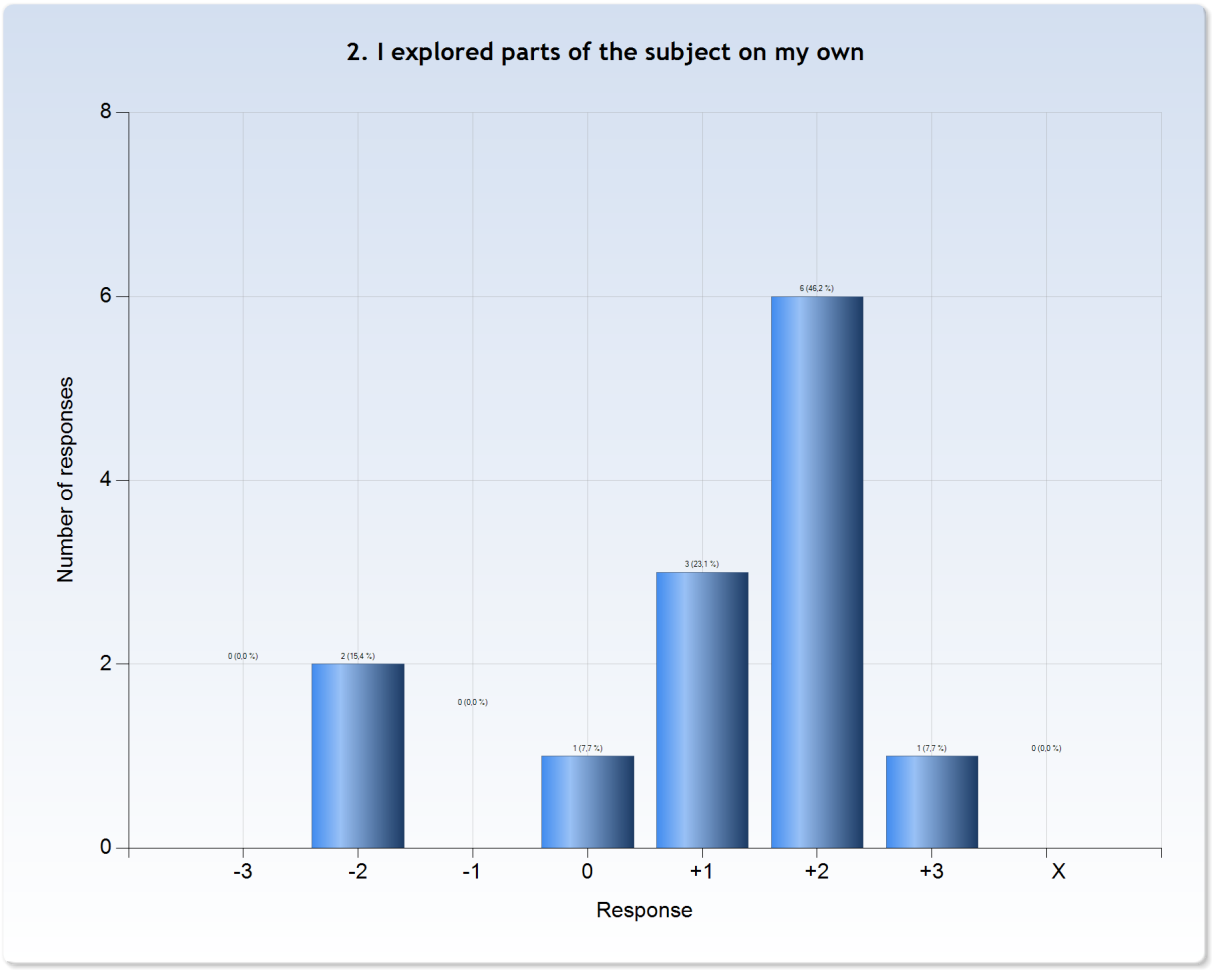
The diagrams below show the detailed response to the LEQ statements. The response scale is defined by:

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

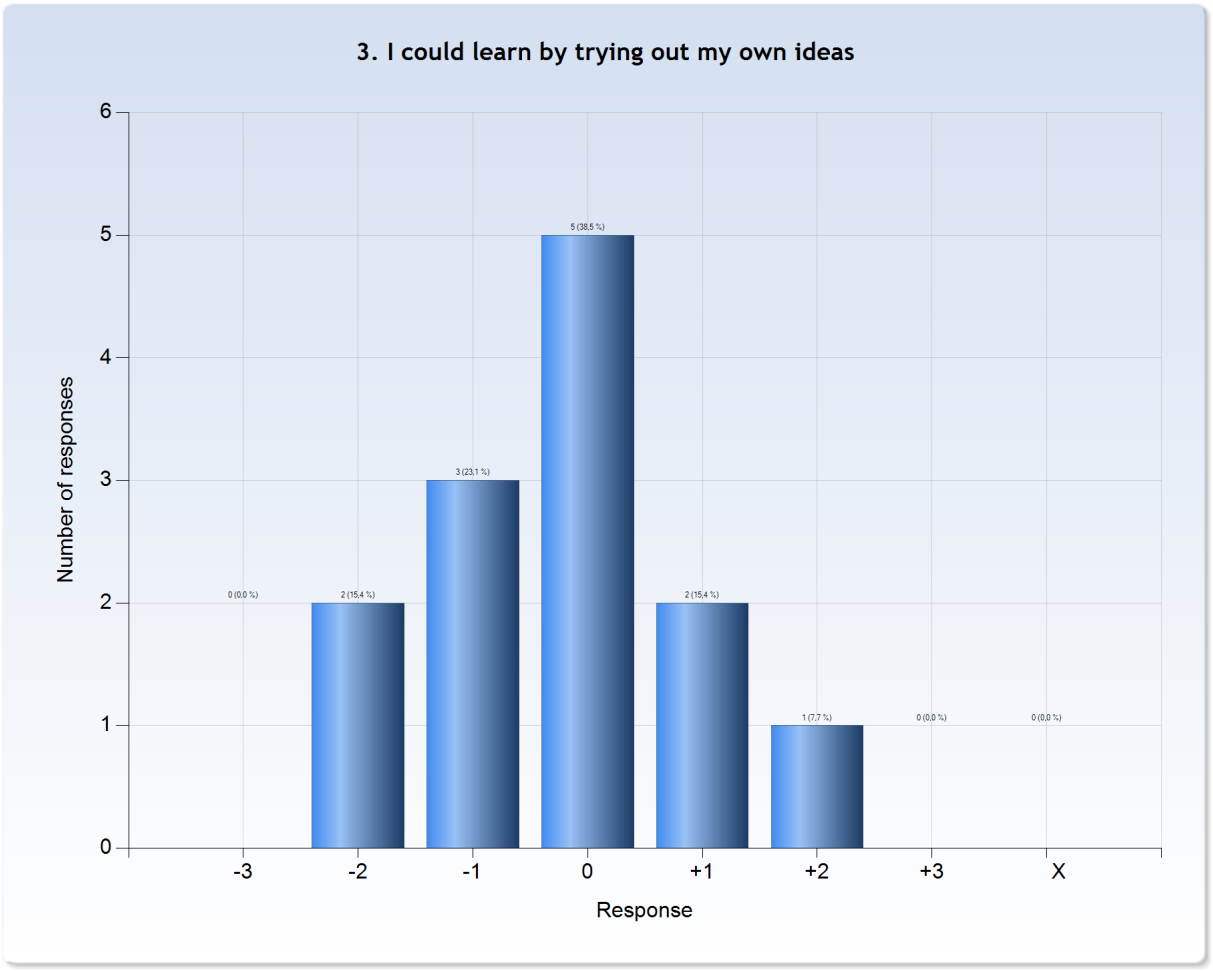
X = I decline to take a position on the statement



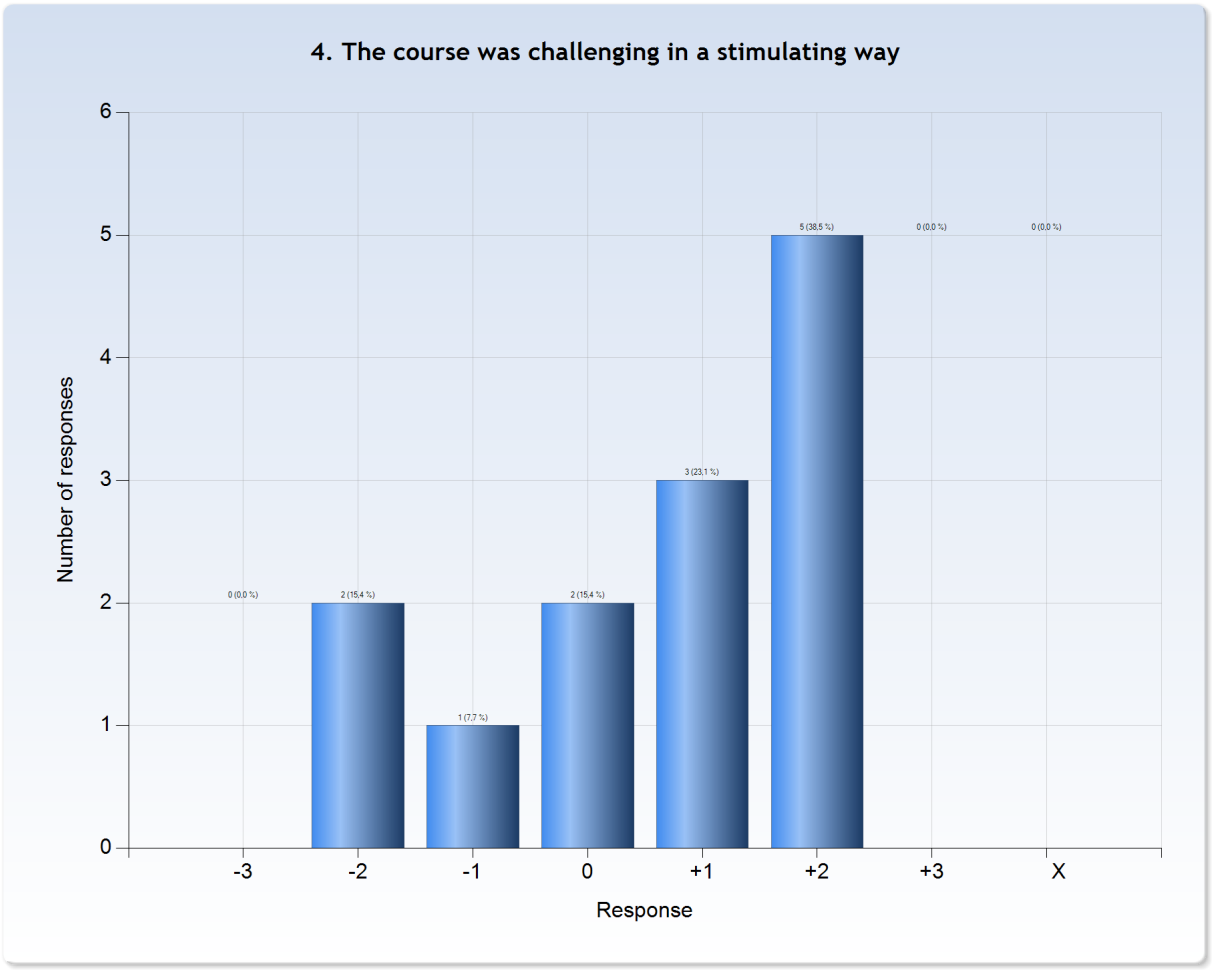
Comments


2. I explored parts of the subject on my own
Number of responses
8
6
4
2
0
0 (0,0 %)
2 (15,4 %)
0 (0,0 %)
1 (7,7 %)
3 (23,1 %)
6 (46,2 %)
1 (7,7 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X
Response

Comments

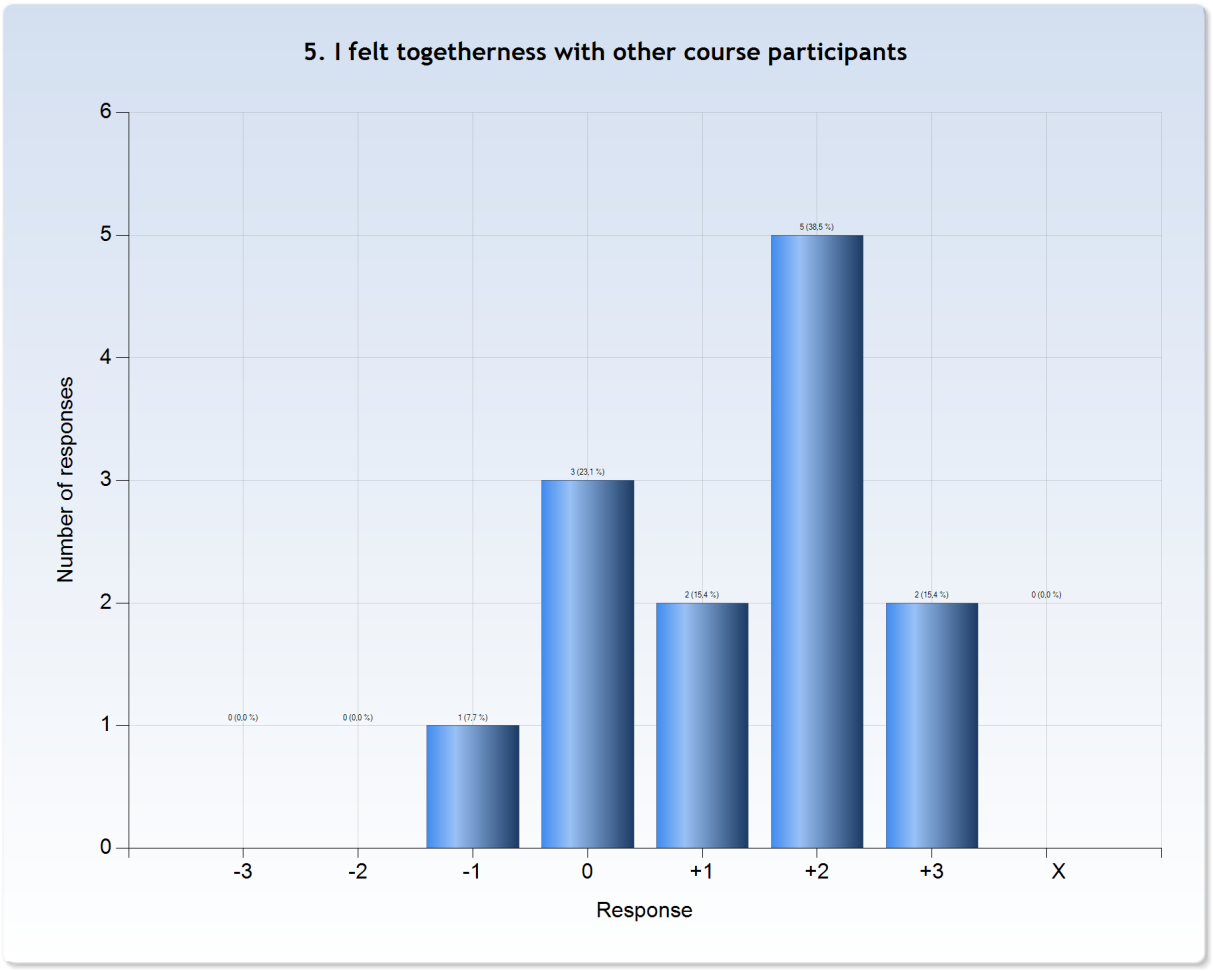

3. I could learn by trying out my own ideas
Number of responses
Response
0
1
2
3
4
5
6
-3
-2
-1
0
+1
+2
+3
X
0 (0,0 %)
2 (15,4 %)
3 (23,1 %)
5 (38,5 %)
2 (15,4 %)
1 (7,7 %)
0 (0,0 %)
0 (0,0 %)

Comments

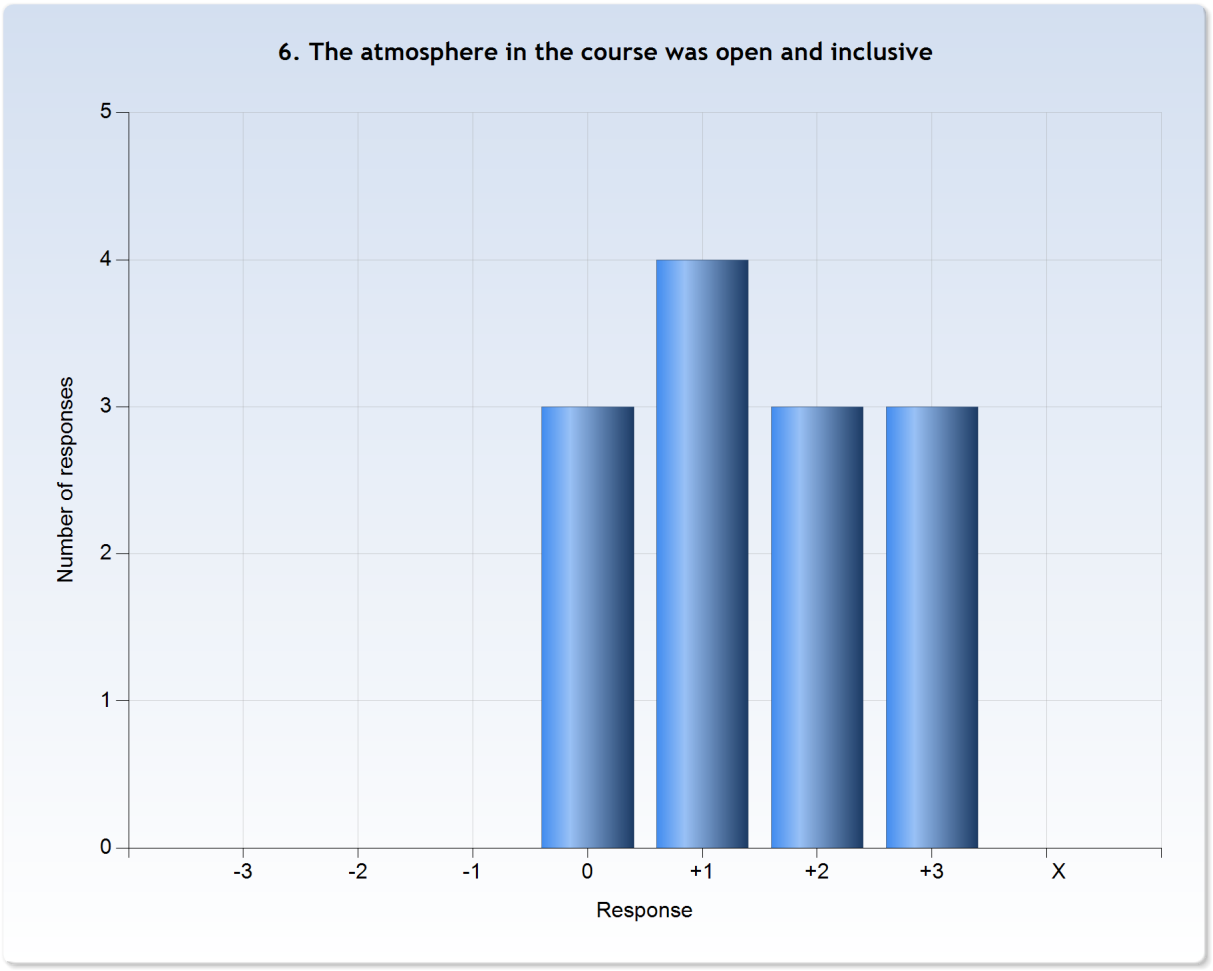


Comments

Comments (My response was: 0)
That's not a scentence

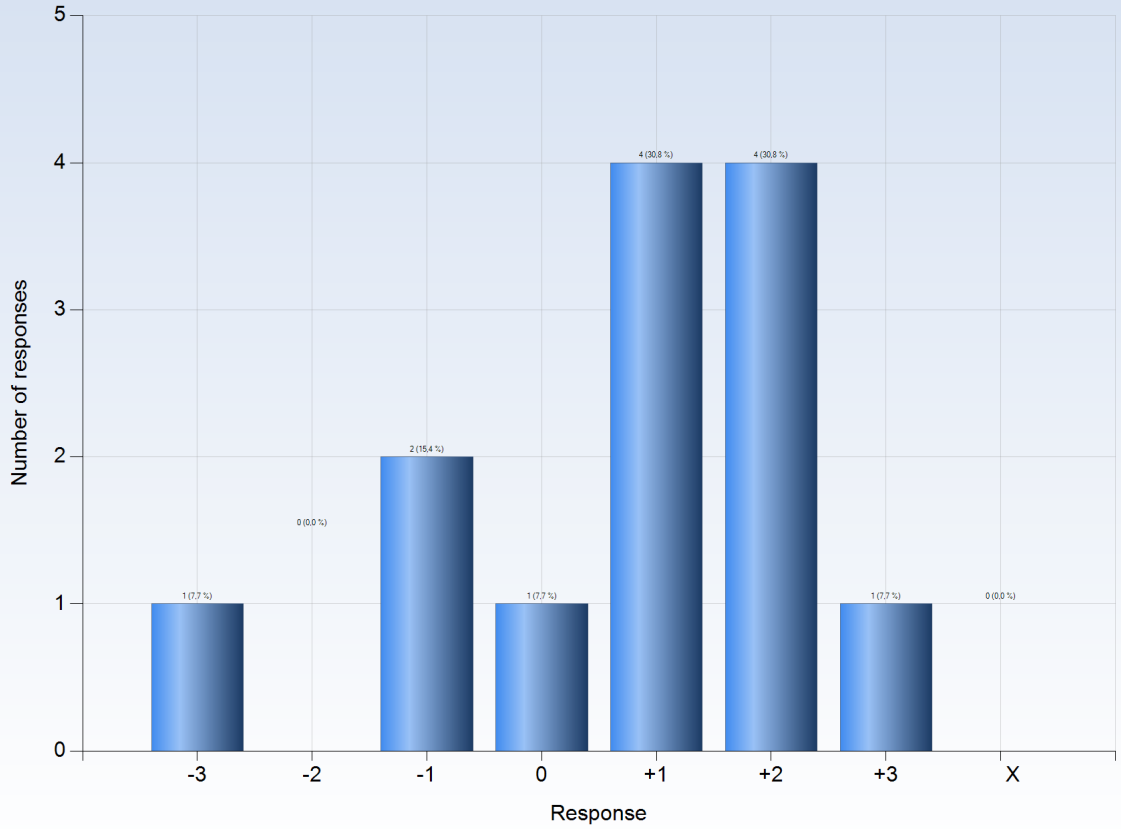

5. I felt togetherness with other course participants
Number of responses
Response
0
1
2
3
4
5
6
-3
-2
-1
0
+1
+2
+3
X
0 (0,0 %)
0 (0,0 %)
1 (7,7 %)
3 (23,1 %)
2 (15,4 %)
5 (38,5 %)
2 (15,4 %)
0 (0,0 %)

Comments


6. The atmosphere in the course was open and inclusive
Number of responses
0
1
2
3
4
5
-3
-2
-1
0
+1
+2
+3
X
Response

Comments

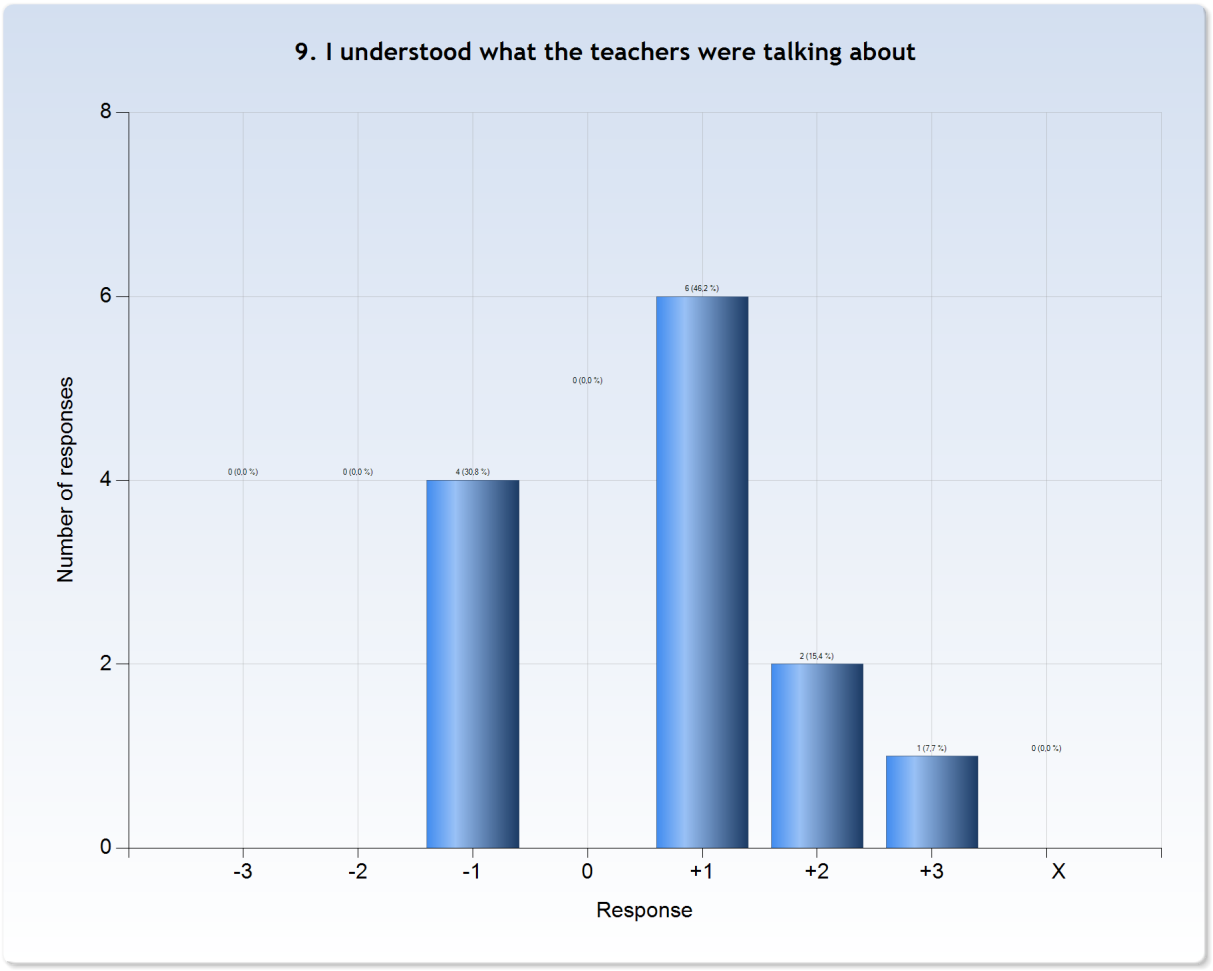
7. The learning objectives helped me understand what I was expected to achieve



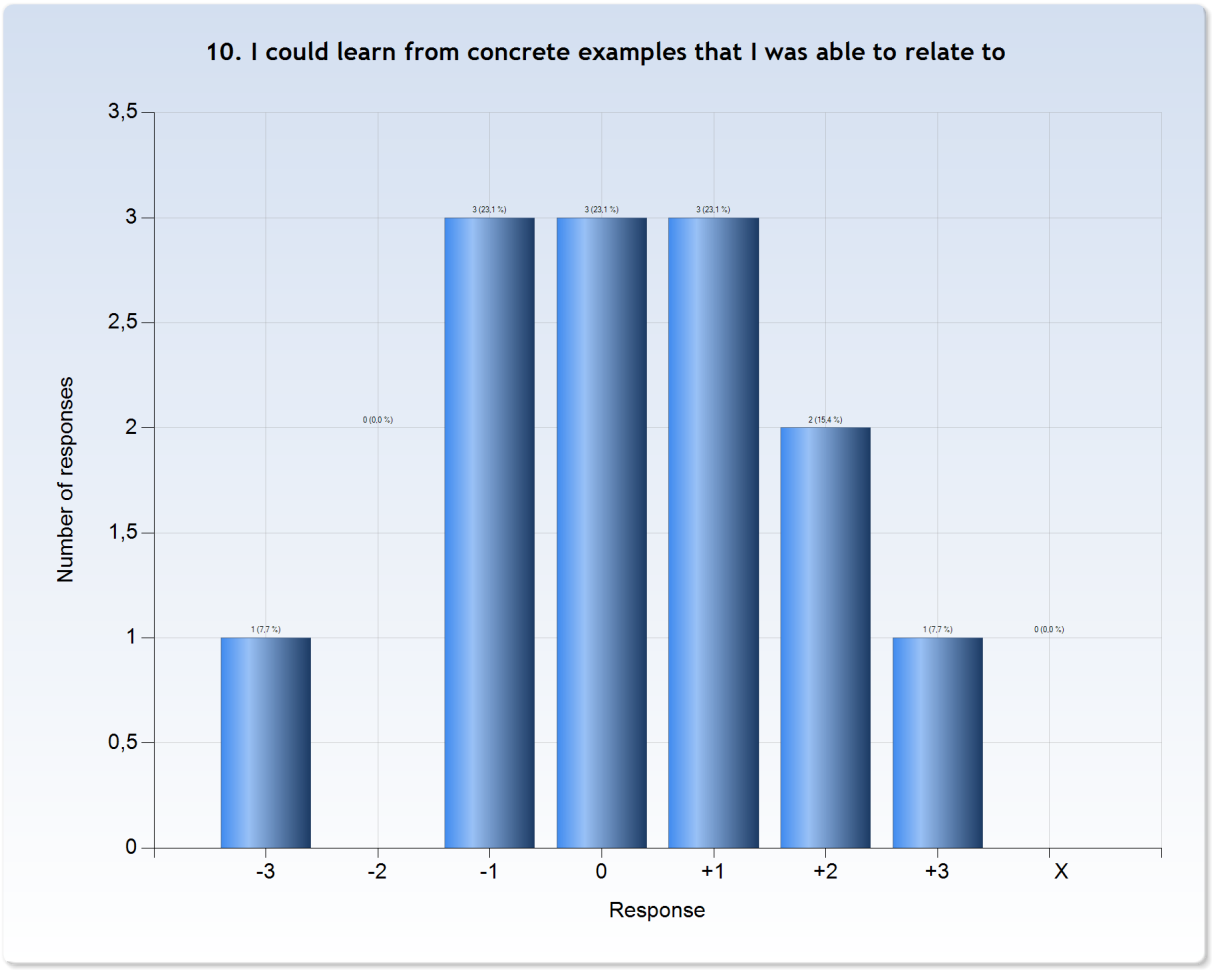
Comments

Comments

Comments (My response was: -3)
Example exams were needed

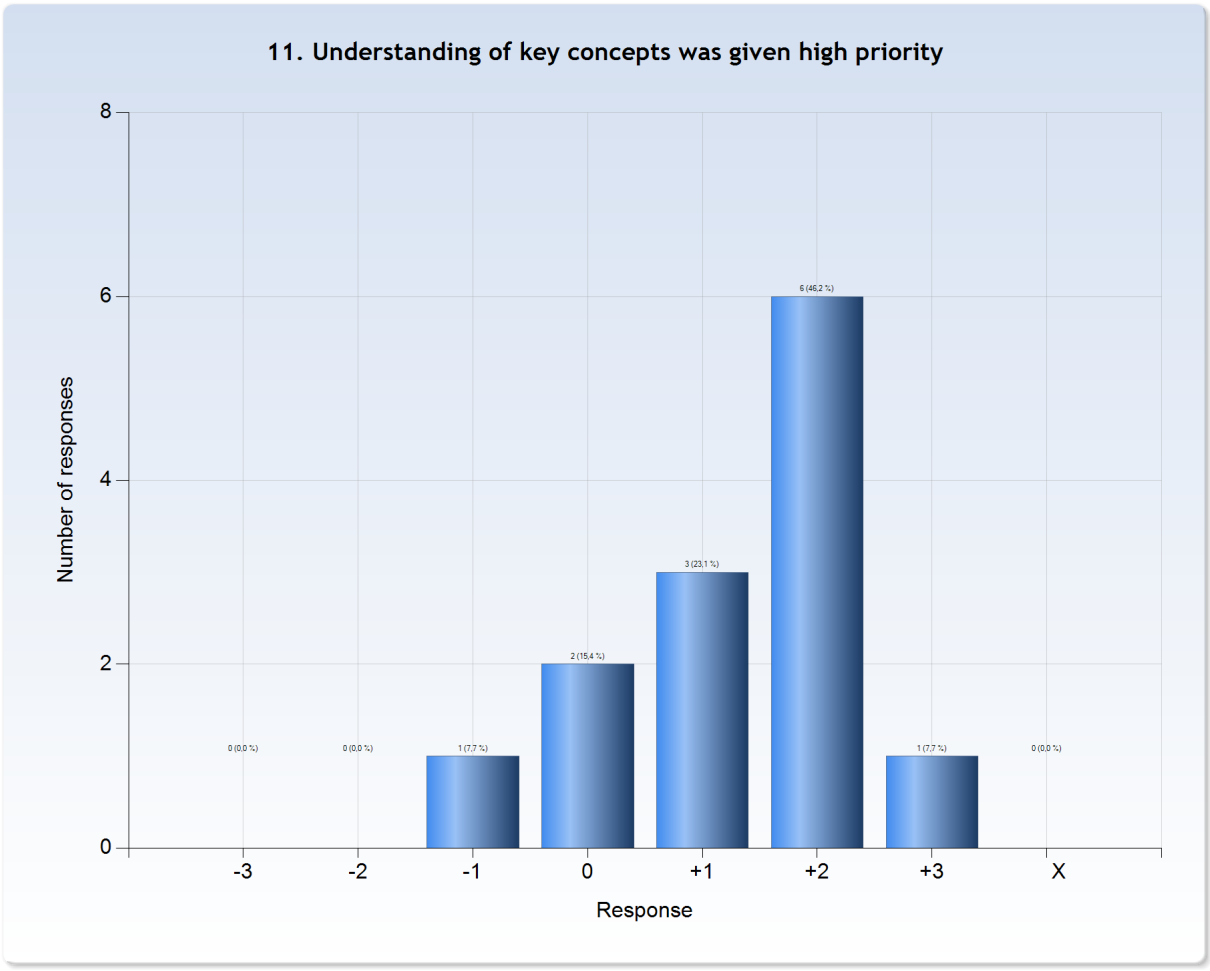

9. I understood what the teachers were talking about
Number of responses
Response
8
6
4
2
0
-3
-2
-1
0
+1
+2
+3
X
0 (0,0 %)
0 (0,0 %)
4 (30,8 %)
0 (0,0 %)
6 (46,2 %)
2 (15,4 %)
1 (7,7 %)
0 (0,0 %)

Comments

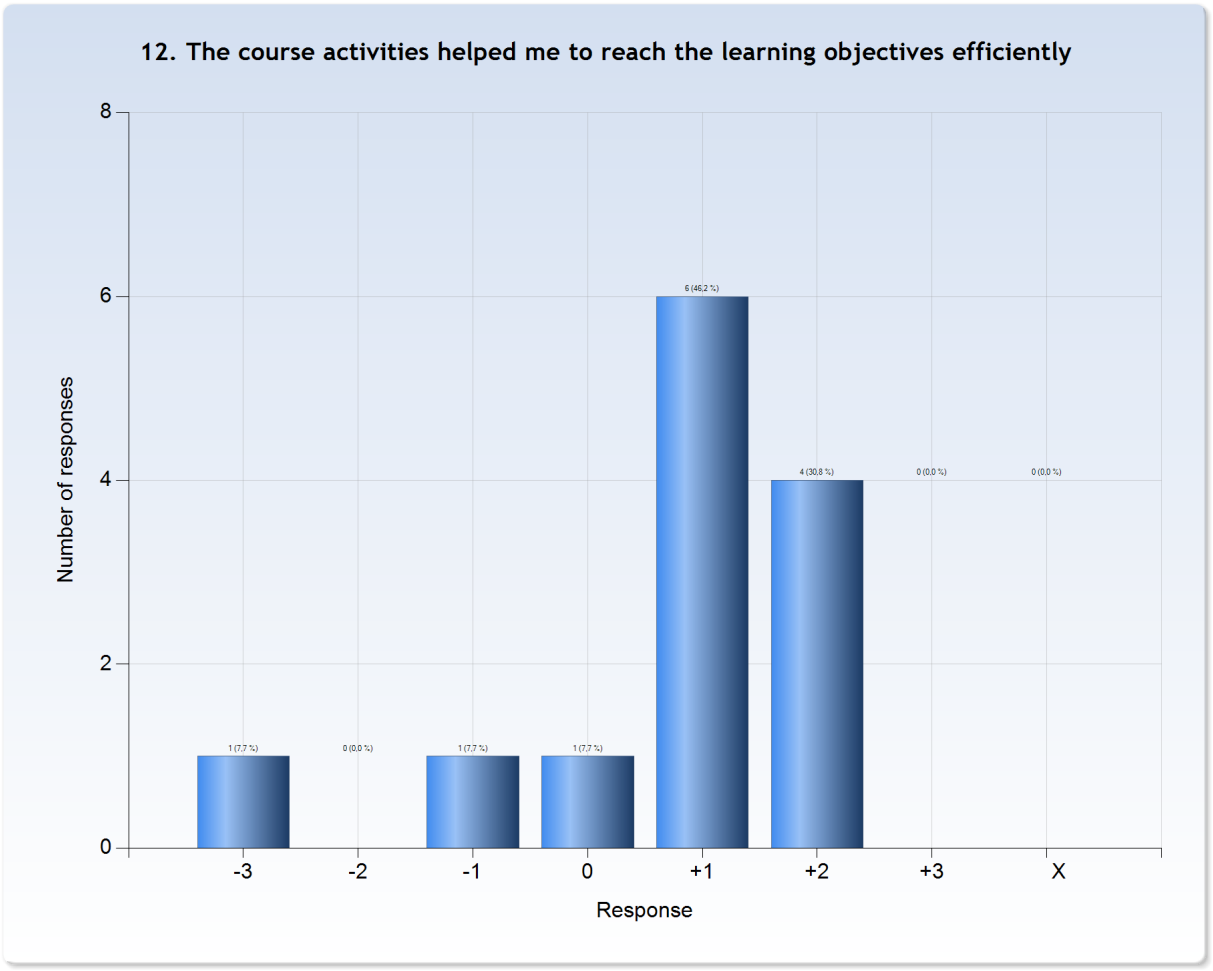


Comments

Comments (My response was: 0)
In the cases of the labs, yes.


11. Understanding of key concepts was given high priority
Number of responses
8
6
4
2
0
0 (0,0 %)
0 (0,0 %)
1 (7,7 %)
2 (15,4 %)
3 (23,1 %)
6 (46,2 %)
1 (7,7 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X
Response

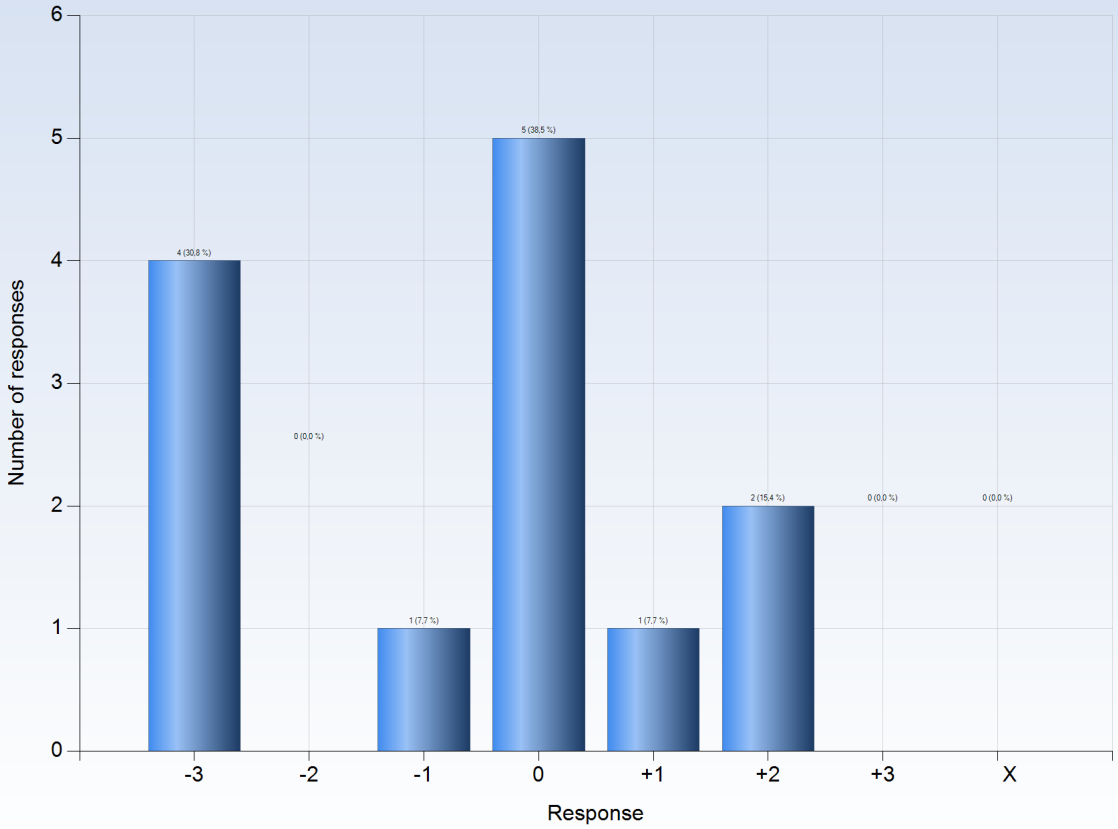
Comments



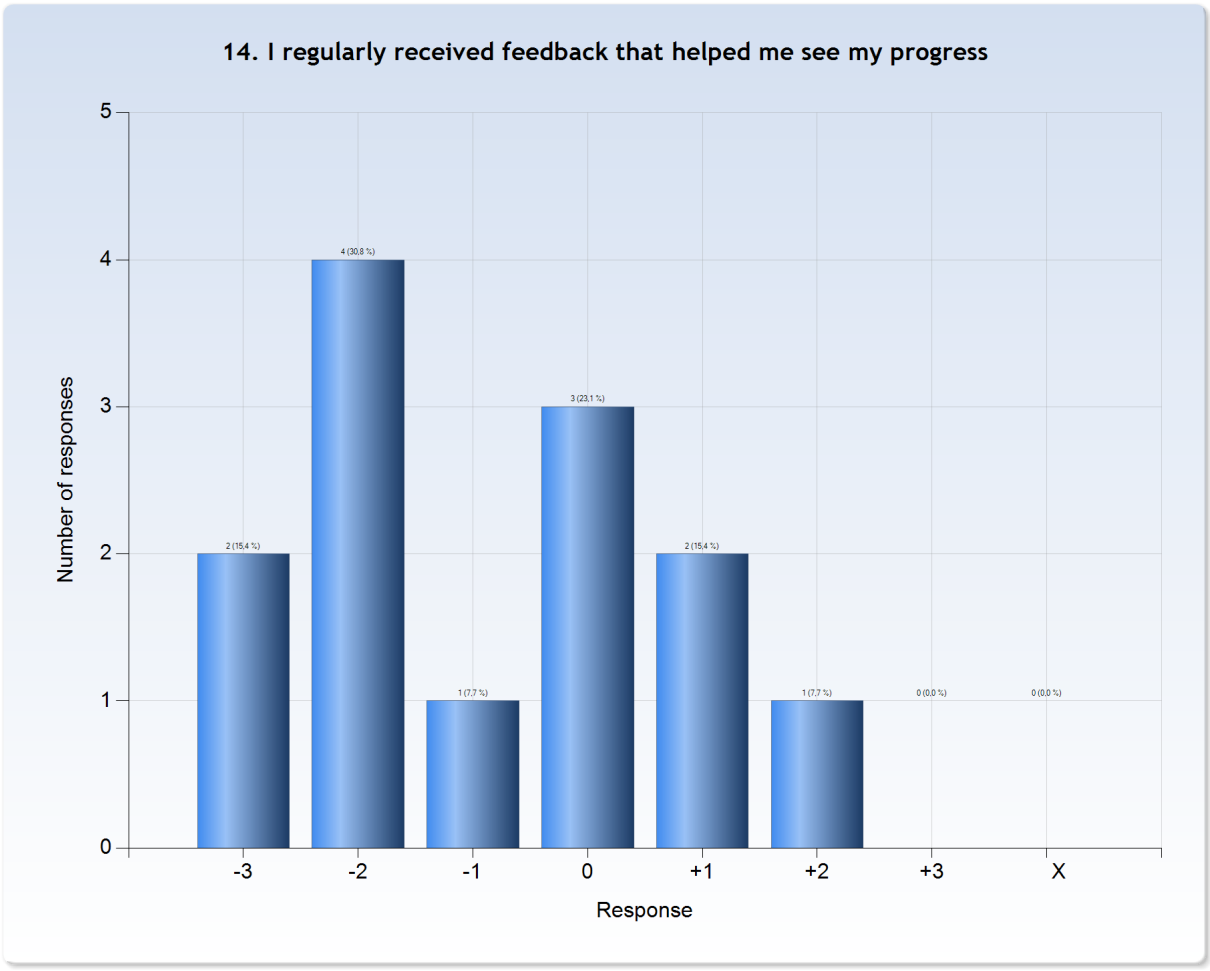
Comments

(My response was: 0)
the areas lacking labs should have extra lectures

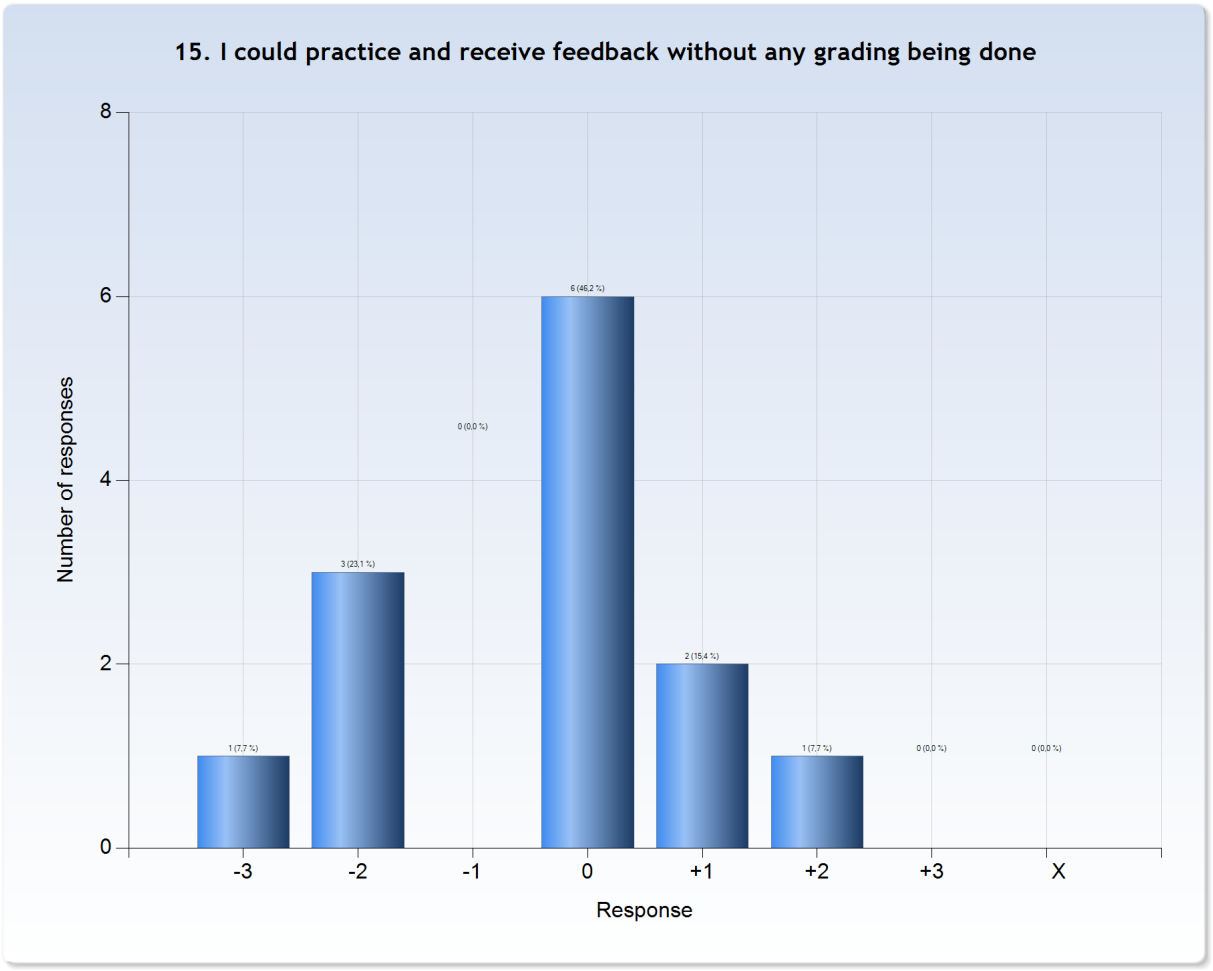
13. I understood what I was expected to learn in order to get a particular grade



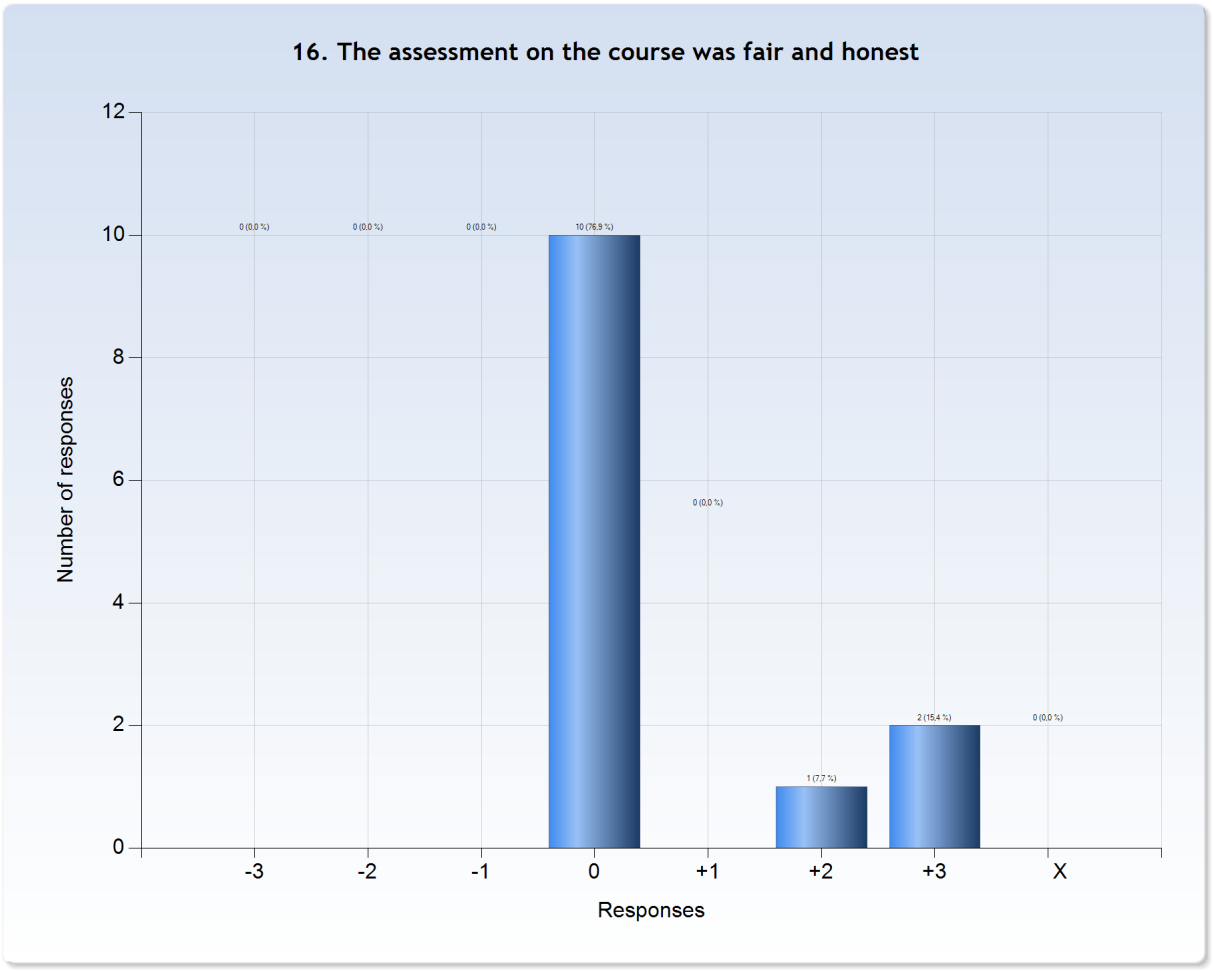
Comments


14. I regularly received feedback that helped me see my progress
Number of responses
0
1
2
3
4
5
2 (15,4 %)
4 (30,8 %)
1 (7,7 %)
3 (23,1 %)
2 (15,4 %)
1 (7,7 %)
0 (0,0 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X
Response

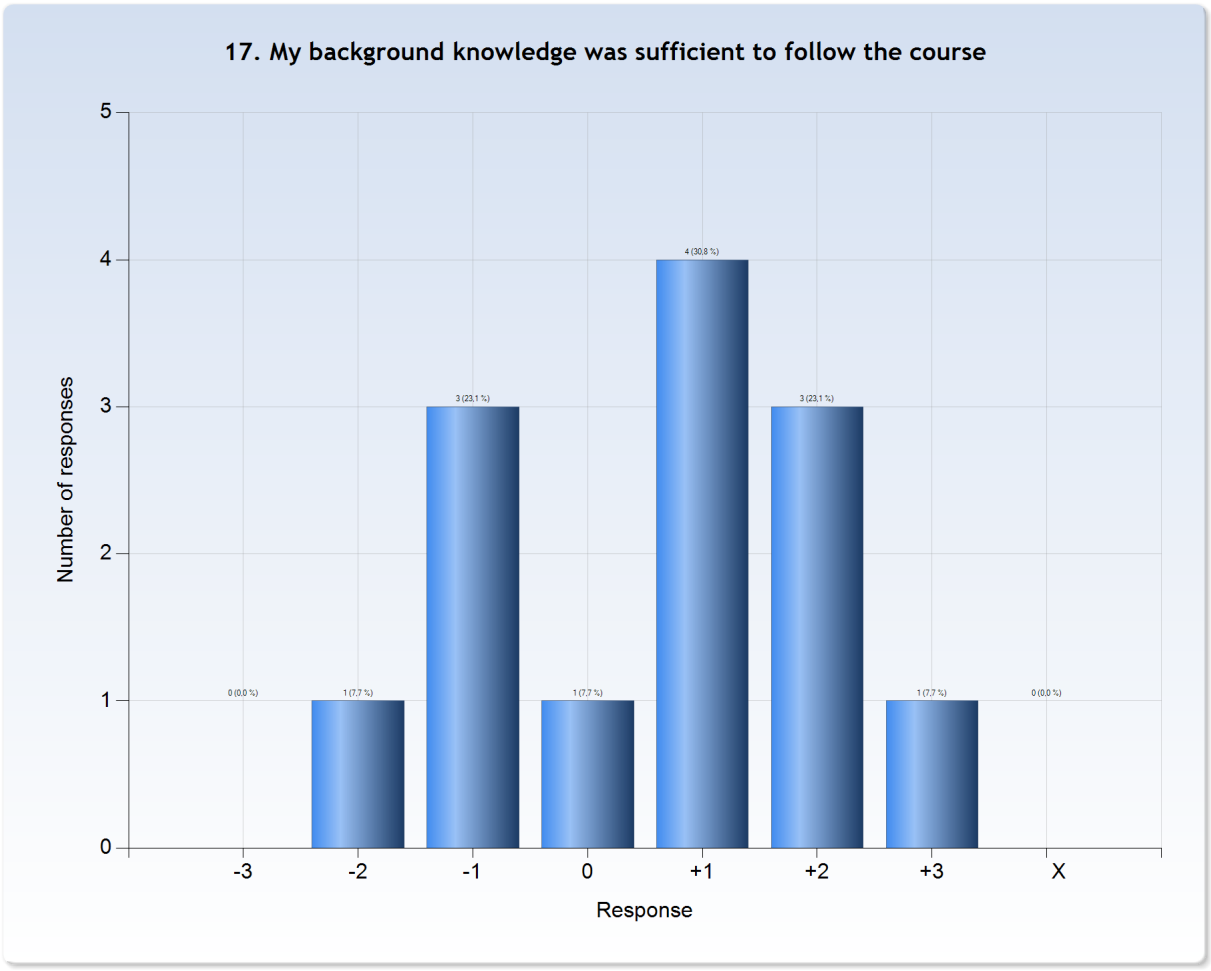
Comments


15. I could practice and receive feedback without any grading being done
Number of responses
8
6
4
2
0
1 (7,7 %)
3 (23,1 %)
0 (0,0 %)
6 (46,2 %)
2 (15,4 %)
1 (7,7 %)
0 (0,0 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X
Response

Comments

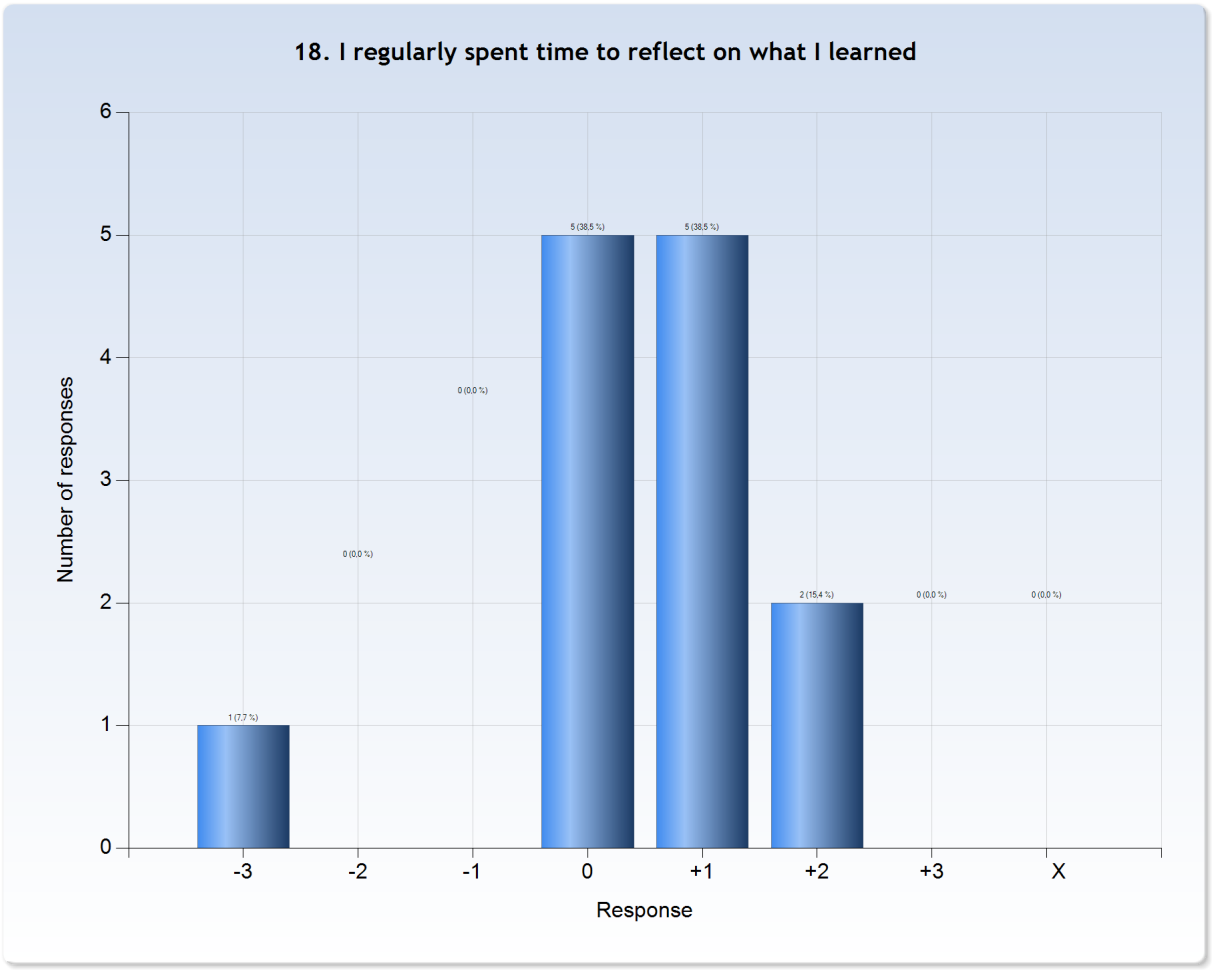

16. The assessment on the course was fair and honest
Number of responses
12
10
8
6
4
2
0
0 (0,0 %)
0 (0,0 %)
0 (0,0 %)
10 (76,9 %)
0 (0,0 %)
1 (7,7 %)
2 (15,4 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X
Responses

Comments

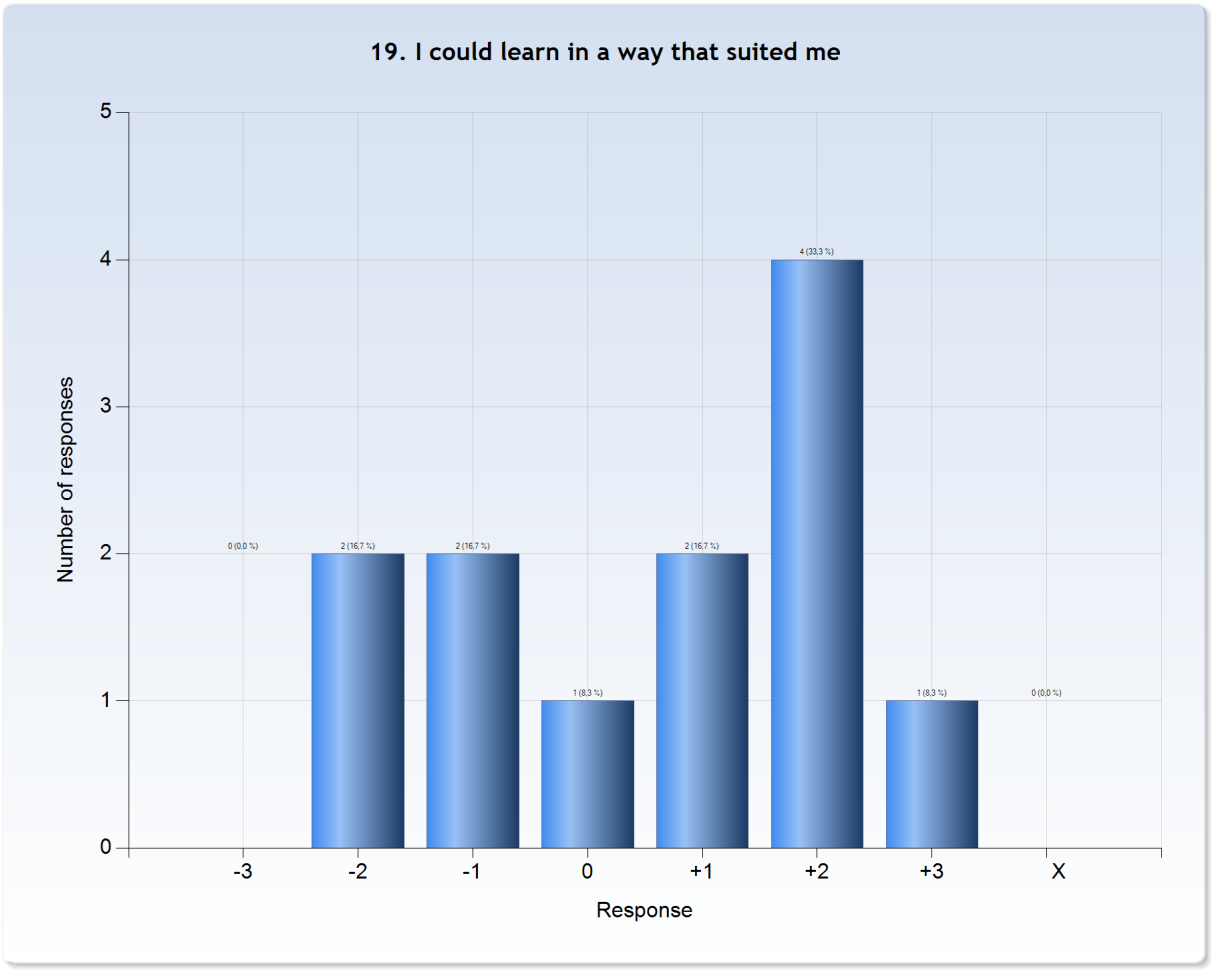


Comments

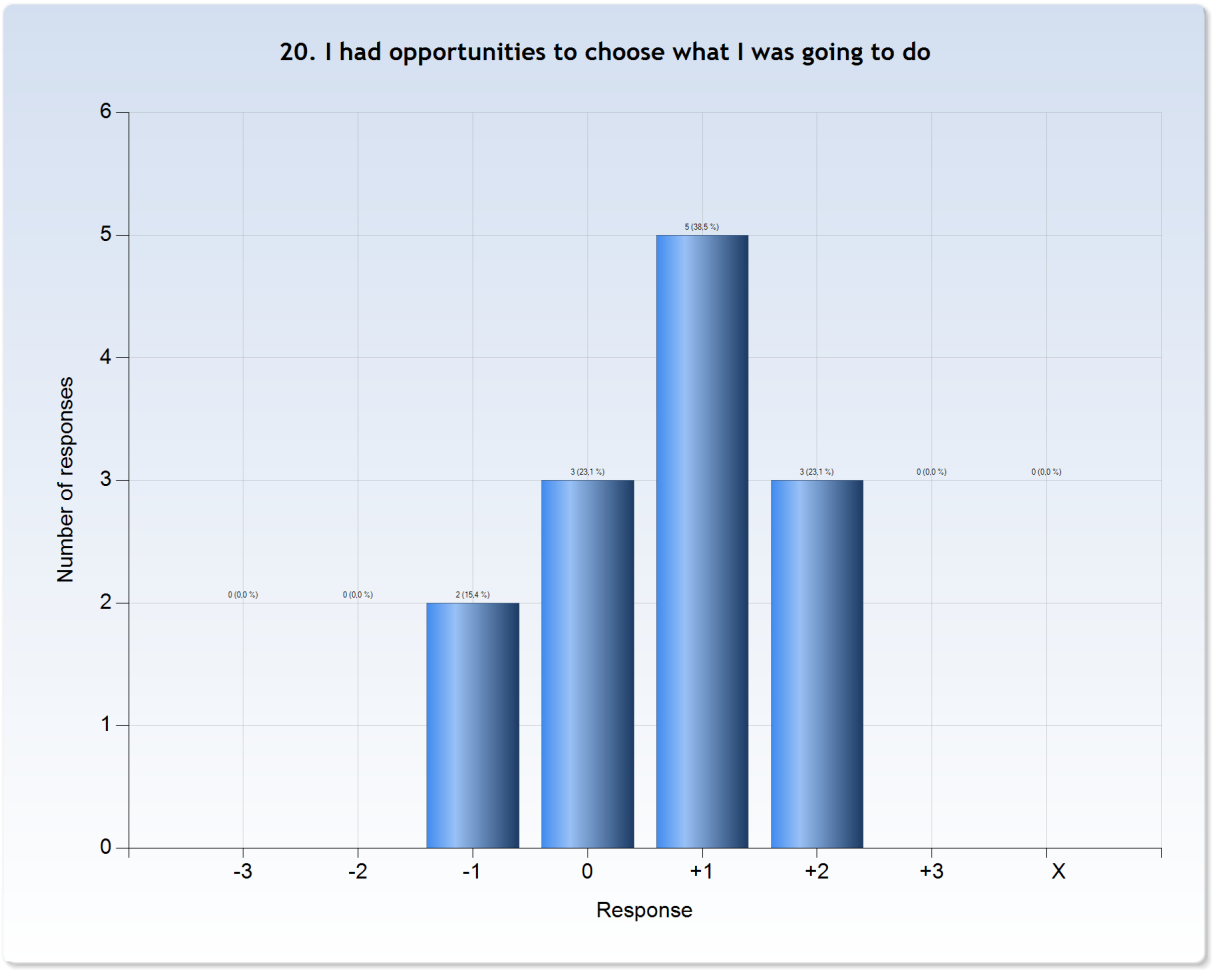
Comments (My response was: -2)
E.g the parallel course in semiconductor devices had not introduced the MOSFET before the lecture treated a lot of MOSFET knowledge as a prerequisite.


18. I regularly spent time to reflect on what I learned
Number of responses
Response
0
1
2
3
4
5
6
-3
-2
-1
0
+1
+2
+3
X
1 (7,7 %)
0 (0,0 %)
0 (0,0 %)
5 (38,5 %)
5 (38,5 %)
2 (15,4 %)
0 (0,0 %)
0 (0,0 %)

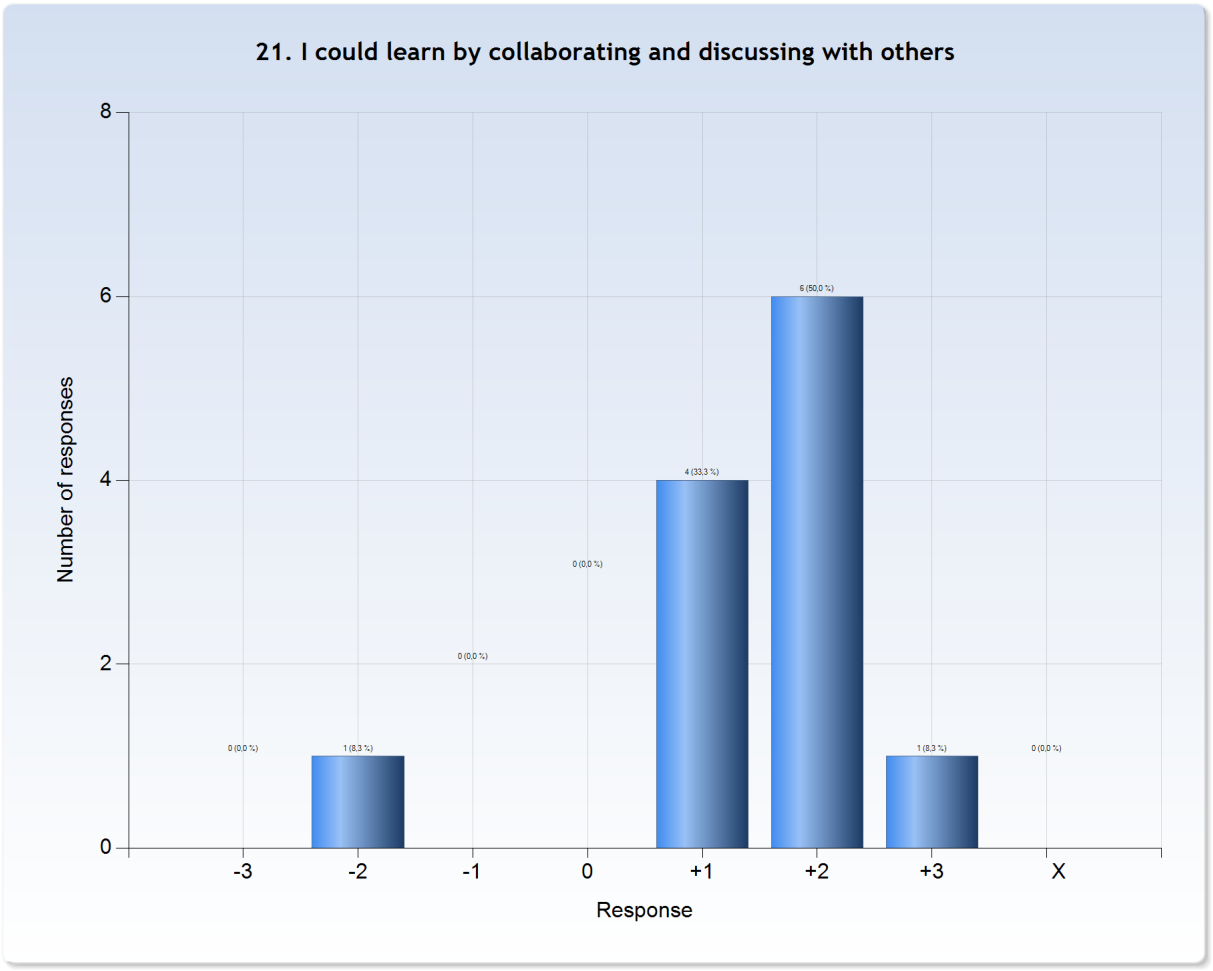
Comments


19. I could learn in a way that suited me
Number of responses
5
4
3
2
1
0
0 (0,0 %)
2 (16,7 %)
2 (16,7 %)
1 (8,3 %)
2 (16,7 %)
4 (33,3 %)
1 (8,3 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X
Response

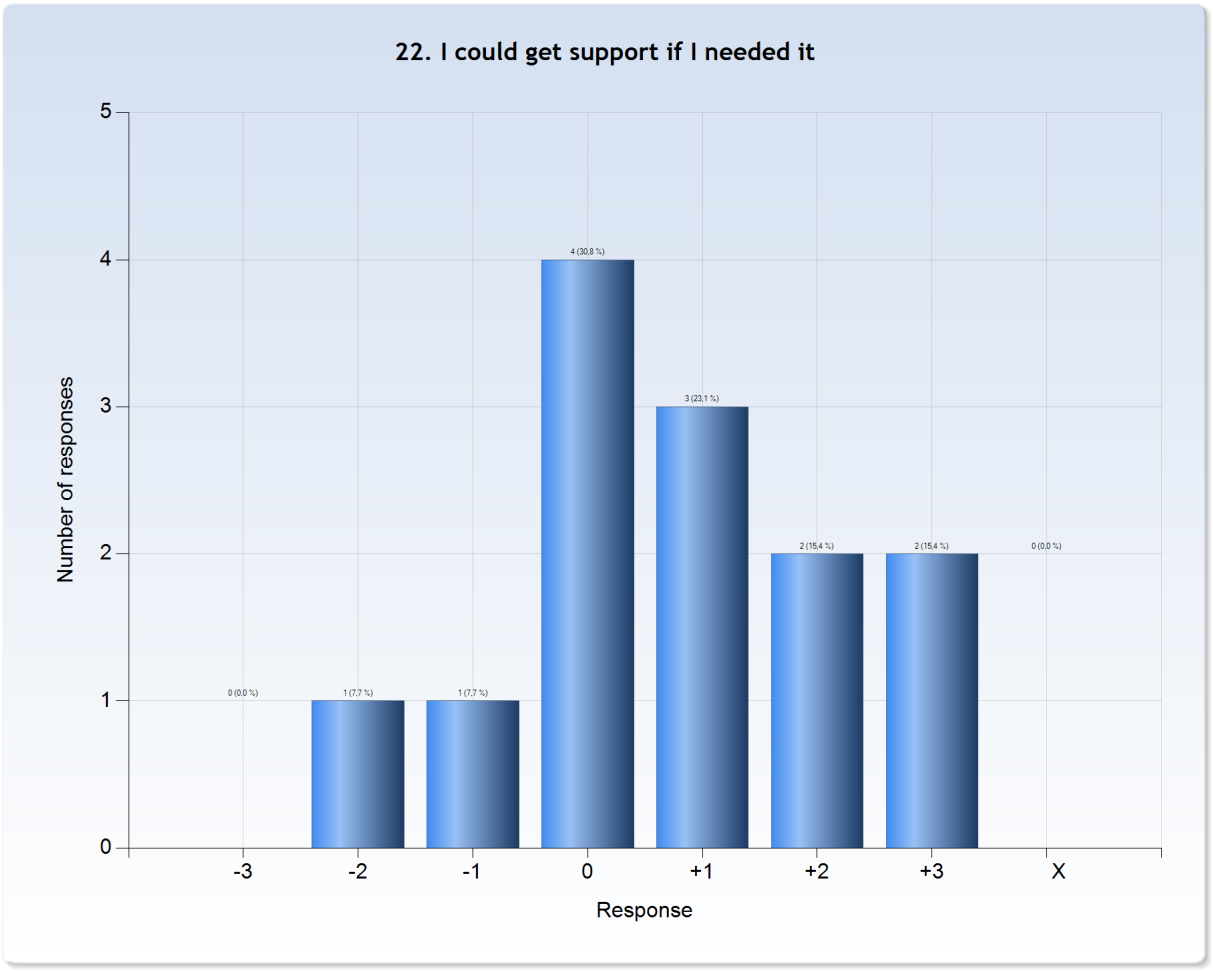
Comments


20. I had opportunities to choose what I was going to do
Number of responses
Response
0 (0,0 %)
0 (0,0 %)
2 (15,4 %)
3 (23,1 %)
5 (38,5 %)
3 (23,1 %)
0 (0,0 %)
0 (0,0 %)
-3
-2
-1
0
+1
+2
+3
X

Comments


21. I could learn by collaborating and discussing with others
Number of responses
Response
0
2
4
6
8
-3
-2
-1
0
+1
+2
+3
X
0 (0,0 %)
1 (8,3 %)
0 (0,0 %)
0 (0,0 %)
4 (33,3 %)
6 (50,0 %)
1 (8,3 %)
0 (0,0 %)

Comments


22. I could get support if I needed it
Number of responses
Response
0
1
2
3
4
5
-3
-2
-1
0
+1
+2
+3
X
0 (0,0 %)
1 (7,7 %)
1 (7,7 %)
4 (30,8 %)
3 (23,1 %)
2 (15,4 %)
2 (15,4 %)
0 (0,0 %)

Comments