

Course analysis KE2045 Chemical Reaction Engineering VT21

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1. Description of the course evaluation process

An online learning experience questionnaire (LEQ) for course evaluation (distributed to students after the final written examination) was used to account for students' opinion regarding the course. The students could optionally specify their gender, study programme, or any disability. Participation reached approximately 47% (7/15). Summarized responses and analysis of the LEQ are attached as an annex.

2. Description of meetings with students

The students could communicate with the teachers via online zoom meetings, via email or via Canvas any time during the course as well as after the final exam. Discussions included questions about the course content, assignments, the examination etc.

3. Course Design

Course description

The course introduces students to chemical reaction engineering and reactor design. The aim is to give an enhanced understanding of the theory of chemical reactors and skill in formulation and analysis of mathematical models in chemical reaction engineering. The classroom problems and the computer laboratory exercises aim to establish problem solving skills with and without computer aid.

Learning Objectives

After completing the course, the students should be able to:

- Identify and describe ideal reactors and their characteristics.
- Develop mathematical expressions (models) to describe the behavior of chemical reactors and analyze how kinetics, mass transfer and heat transfer affect the performance of the reactors
- Apply analytical and numerical methods to determine reactors' behavior and analyze the results.
- Size and design chemical reactors and optimize operating conditions
- Apply RTD (Residence Time Distribution) methods to diagnose non-ideal flows in reactors and calculate conversions

Course Design

The course is based on three different modules that try to address the above-mentioned learning objectives. Namely, theory and problem solving, classroom and home problems and computer labs.

The theory and problem-solving part of the course consists of three sections, namely: ideal reactor models, heterogeneous systems and non-ideal reactors. This provides the fundamental concepts of

reactors theory and describes the important mathematical relationships needed to size and analyze them. This year, the theory was provided in hybrid synchronous-asynchronous teaching form (online recorded and pre-recorded lectures). The online lecture offers the benefits of synchronous learning (i.e., immediate feedback and the interaction between the students, the teacher, and the peers) but the recorded videos allow also for asynchronous learning classroom where the students can see the lecture at their own pace fast forwarding parts that already understood and repeating parts/concepts that were difficult to grasp. The self-regulated learning pace is as an important aspect of deep learning experience¹ and allows the students with different learning cultures or even disabilities to achieve a better understanding. The self-regulated pace also minimizes phenomena of delayed understanding to students which have been shown in environments where teaching pace is totally controlled by the teacher¹. The students can evaluate their understanding of by taking non-graded online quizzes on Canvas platform.

Home and classroom problems are exercises that are solved by students working in small groups. Classroom problems are solved by the students with the help of the teachers, if needed. The help is provided in the form of problem discussion. This helps establishing and structuring relationships between students, teachers and peers, which make students feel more included and confident with their asynchronous engagements (e.g., home problems). The classroom problems allow the direct interaction of students with the teacher during problem solving and get peer feedback from the other participants. The home problems are solved by the students at home usually with the help of computers for solving the equations using numerical techniques. Some of the home problems are linked to the computer laboratory exercises.

Computer laboratory exercises are also carried out in groups. By this, the students exercise the whole chain from a problem in chemical reaction engineering, formulating a mathematical problem, choosing numerical algorithms, calculation methods and computer software, and doing the computer calculations in the computer classroom. The presence of a teacher in the computer lab helps to establish correct understanding of solution procedures and computer programming techniques.

The classroom problems and the computer laboratory exercises aim to enhance problem solving skills both with and without computer usage. For passing the course is it essential to participate in classroom problem solving.

The final assessment is carried out in form of a 3.5 hour written 'take home' exam and oral examination

4. Students' workload

Given the course structure and the short duration a relatively high load is expected. The students' responses were distributed over a large workload span. 28.6% of the responses indicated a workload greater than 30 hr/week. 14.3% of the responses indicated a 27-29 h /week workload. On the other hand, 57.2% of the students reported a workload less than (or equal to) 14 h/week. Given that the the questionnaire's response rate is less than 50% and the distribution of responses is bimodal (either too high or too low workload), it is risky to conclude whether the workload deviates from the expected. However, based on the students' comments, albeit the workload was relatively high it is perceived as a good learning experience which comes in line with comments from previous years (see 7. Summary of students' opinions).

5. Students' results on the course

The results from the course are summarized in the table below. Previously registered students (some of them with first registration in 2017) did not participate in the written exams neither in June nor in the reexam in September. There was a considerable amount (23%) of first registration students that decided not to take the exam in June because of heavy workloads from other courses. This year another course exam was set the day after, and many students felt that they need more time to prepare for this course thus did not take the exam in June.

The students did not excel in the written exam in June despite showing good performance in the assignments and classroom problems during the period (at least most of them). This can be ascribed to the above-mentioned limited time for preparation as well as the tight examination schedule. Giving additional time to study allowed the students to perform much better with 83% in the re-exam with 83% of the students being able to pass the course (5/6).

Total No. of registered students	17
No. of first registration students	13
No. of students taking the exam	10
No. of first registration students taking the exam	10
No. of students taking the re-exam	6
No. of first registration students taking the re-exam	6

	Grade	A	B	C	D	E	F	Did not take exam
Exam	No. of students	0	0	1	1	3	4	7
Reexam	No. of students	1	0	0	2	2	1	3

6. Students' answers to open questions

Most of the students appreciated the classroom problems and the continuous active participation evaluation and preparation for the exam through the different activities.

The distribution of the assignments over the teaching period might be of a concern even though that was improved from previous year. Some of students felt that the assignments were increased towards the end of the period, which was closer to the exams. Things to improve include the addition of extra solved exercises either during lectures or as additional material.

7. Summary of students' opinions

The students indicated that it is a demanding course with many assignments/deliverables during the course which, however, stimulated their understanding. Even though additional examples were uploaded on Canvas platform, the students indicated that they would like to have more solved examples as a resource to help them understand some concepts easier. The course content was very adapted to previous knowledge but also enriched with industrial contemporary and real-life related issues. Classroom problems sessions were considered very valuable, but group dynamics and interaction were hindered by the online environment (breakout rooms in zoom environment). The

students indicated that the duration of the take home exam was too short, and they felt very much stressed.

8. Overall Impression

The students seemed to respond quite well to the changes implemented and even though the course being demanding, they seemed to appreciate the extra effort. They felt included in all course's activities, considering the circumstances that the course was given (zoom – breakout rooms), which they stimulated their understanding in different ways.

9. Analysis

Based on the responses:

The meaningfulness of the course was well perceived by the students and most of the students felt that the topics discussed were very interesting, contemporary and all the respondents had a neutral to positive response. Also, most of the respondents said they explored things on their own to some extent.

However, the distribution of the answers indicates that some of the students did not test some of their own ideas or learn from experience. The course allowed for freedom in learning attitude in a supportive environment. The students felt included in the community and worked together.

Most of the students felt that it was clear what the learning objectives of the course as well as the course structure would be.

All the respondents felt that the course was challenging but at the same time stimulating. This is also indicated in their general comments section for the course. The course was demanding however the students report that they had some time to reflect on their understanding yet the preparation time for the exam might have not been enough. This is particularly true for periods 1 and 4 of 1st year in the MSc programme as has also been indicated and discussed with the programme coordinator. The broad distribution of student's responses regarding course activities indicate that there are limited opportunities for them to influence the course activities. This may have to do with the many predefined tasks that they must deal with and in this occasion the online teaching.

No conclusions on gender perspectives, students' programme (national/international) and disability could be reached since the responses were not enough to generate any meaningful figures.

It has to be noted that, it may be risky to rely solely on students' responses on learning experience due to rather low response rate and the correlation of response to grade expectations². Distributions and their comments might be more valuable.

10. Prioritized course development

Given the situation, the responses and interactions with the students, the teachers feel that enhancement of hybrid learning activities and structures should be emphasized. Additional time in the course activities should be given to students for practicing the key concepts and additional examples of solved problems (preferably recorded videos) should be provided as also indicated in their responses. Distribution of the assignments and their deadlines over the teaching period will be

reviewed. Restructuring of computer labs and connection to the home problems is under consideration, minimizing in this way the student's deliverables without compromising the learning activities. Computational essays might be adapted as reporting system for the computer labs. Social sustainability aspects need to be better incorporated in the course. Finally, effort in increasing students' participation in LEQ should be put to enhance the feedback for the course's development.

11. Other information you want to share

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References

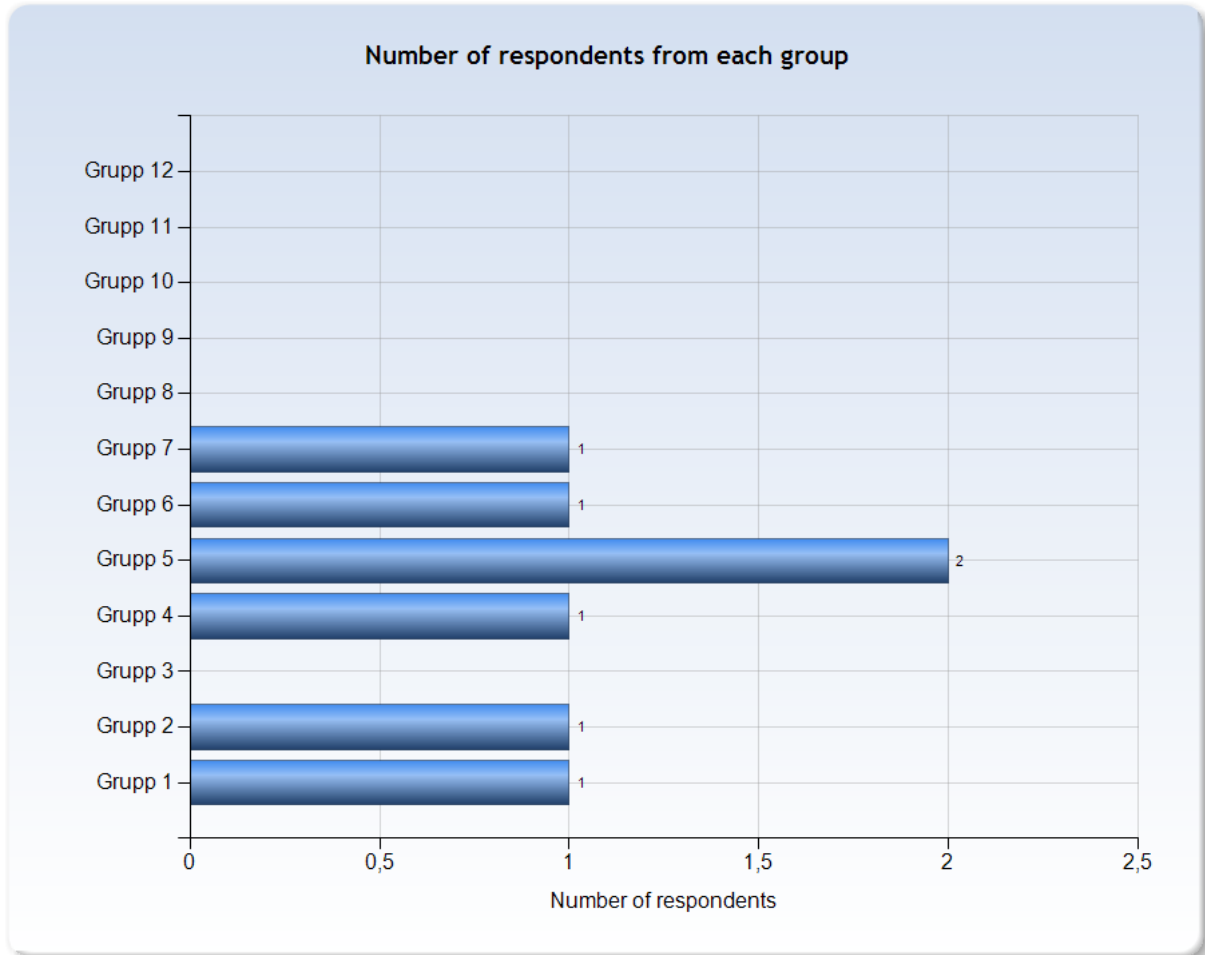
- (1) Entwistle, N. Building Background Knowledge for Academic Achievement; Red Globe Press, 2009; p 224.
- (2) Stark, P.; Freishtat, R. An Evaluation of Course Evaluations. *Sci. Res.* **2014**. <https://doi.org/10.14293/s2199-1006.1.sor-edu.aofrqa.v1>.



KE2045 - 2021-06-11

Antal respondenter: 15
Antal svar: 7
Svarsfrekvens: 46,67 %

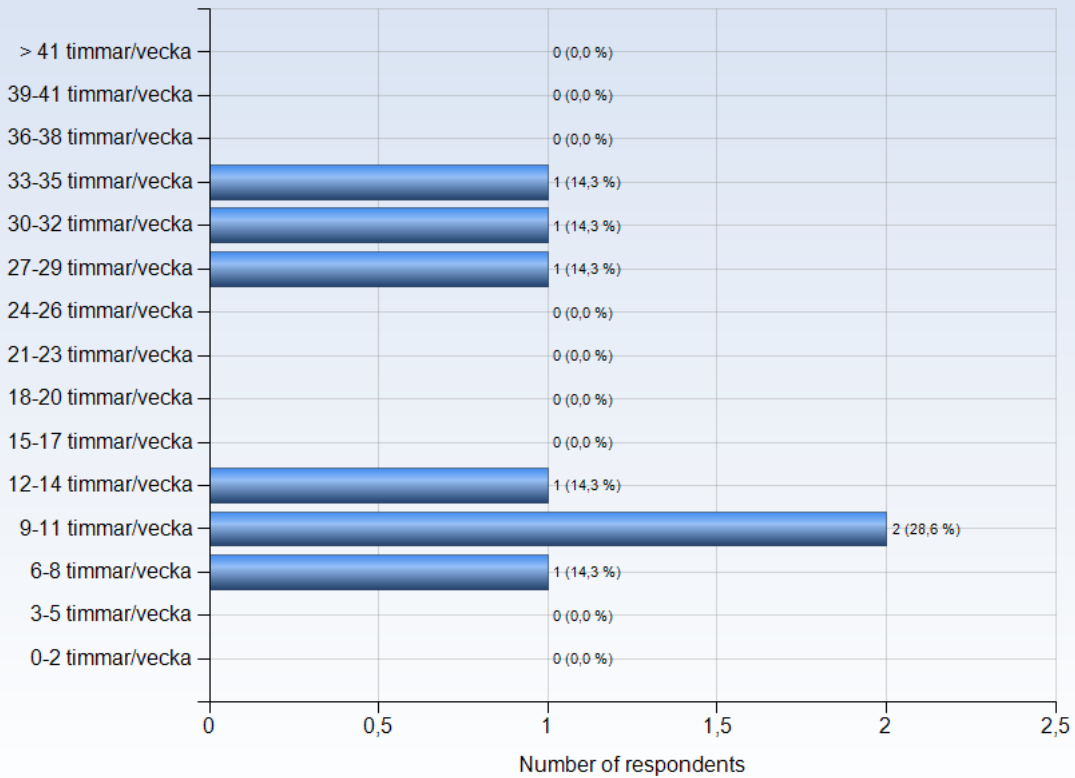
GROUP MEMBERSHIP



Comments

ESTIMATED WORKLOAD

On average, how many hours/week did you work with the course (including scheduled hours)?



Comments

Comments (I belonged to: Grupp 1)

Most of the time was spent on labs, and home problems

Comments (I belonged to: Grupp 5)

Having taken 2 more courses during the same period, the workload for this course was a bit much, difficult to follow in order to get everything done in time.

Comments (I belonged to: Grupp 7)

All the assignments were quite time consuming, but a good learning experience.



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.



KTH Learning Experience Questionnaire v3.1.4

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. The course was organized in a way that supported my learning (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 participation

19. The course activities enabled me to learn in different ways (m)

20. I had opportunities to influence the course activities (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, exciting or important
- b) We are able to speculate, test 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 and at the same time supportive environment
- d) We feel that we are part of a community and believe that other people have confidence 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 adequate prior knowledge to deal with the current learning situation
- g) We are able to learn inductively by moving from concrete examples and experiences to general principles, rather than the reverse
- h) We are challenged to develop a true understanding of key concepts and gradually create a coherent whole from the content
- i) We believe that the work we are expected to do will help us to achieve the intended learning outcomes
- j) We are able to try, fail, and receive feedback before, and separate from, each summative assessment of our efforts
- k) We believe that our work will be considered in an honest and fair way
- l) We have sufficient time for learning and devote the time needed to do so



m) We believe that we have control over our own learning, and not that we are being manipulated

n) We are able to collaborate 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.

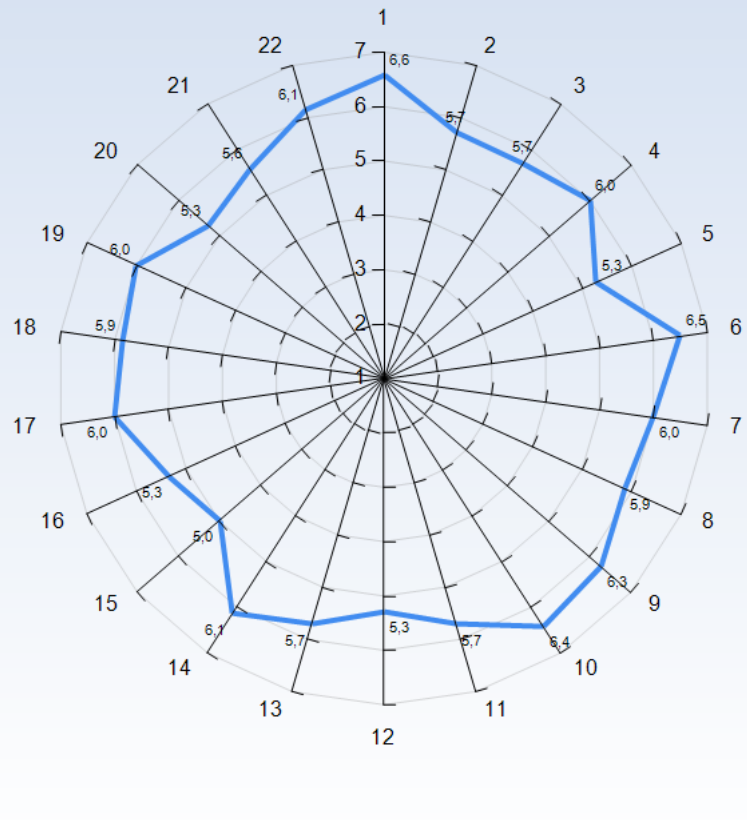
Biggs J. & Tang, C. (2011). *Teaching for Quality Learning at University*, Chapter 6, pp. 95-110. Maidenhead: McGraw Hill.

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

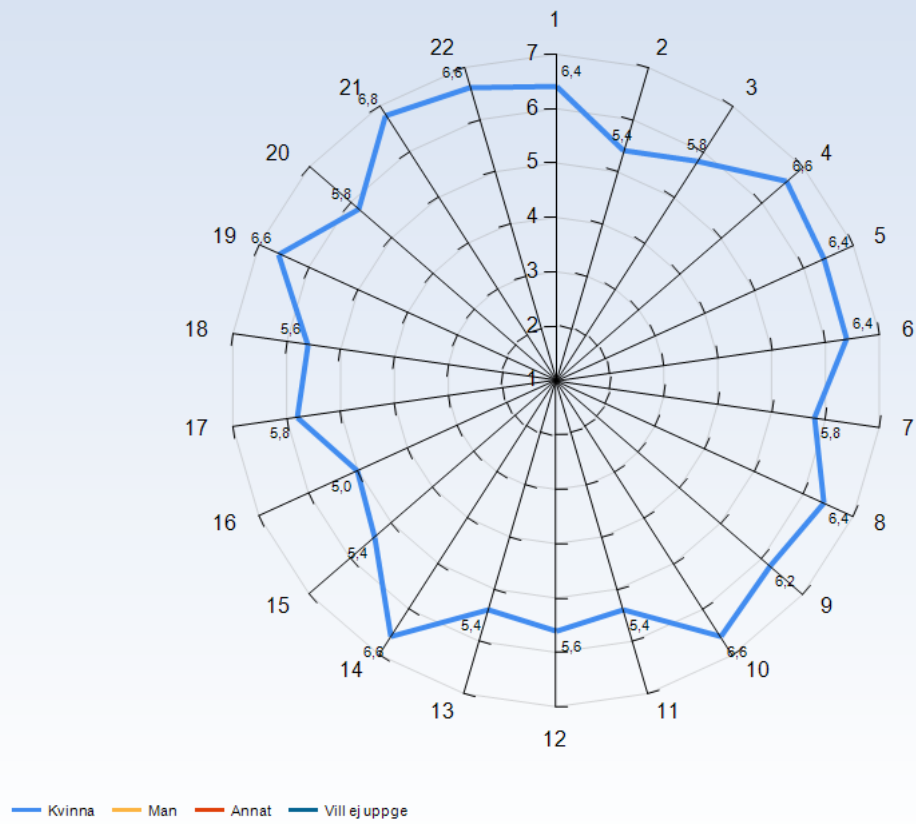
Kember, K. & McNaught, C. (2007). *Enhancing University Teaching: Lessons from Research into Award-Winning Teachers*, Chapter 5, pp. 31-40. Abingdon: Routledge.

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

Average response to LEQ statements - all respondents

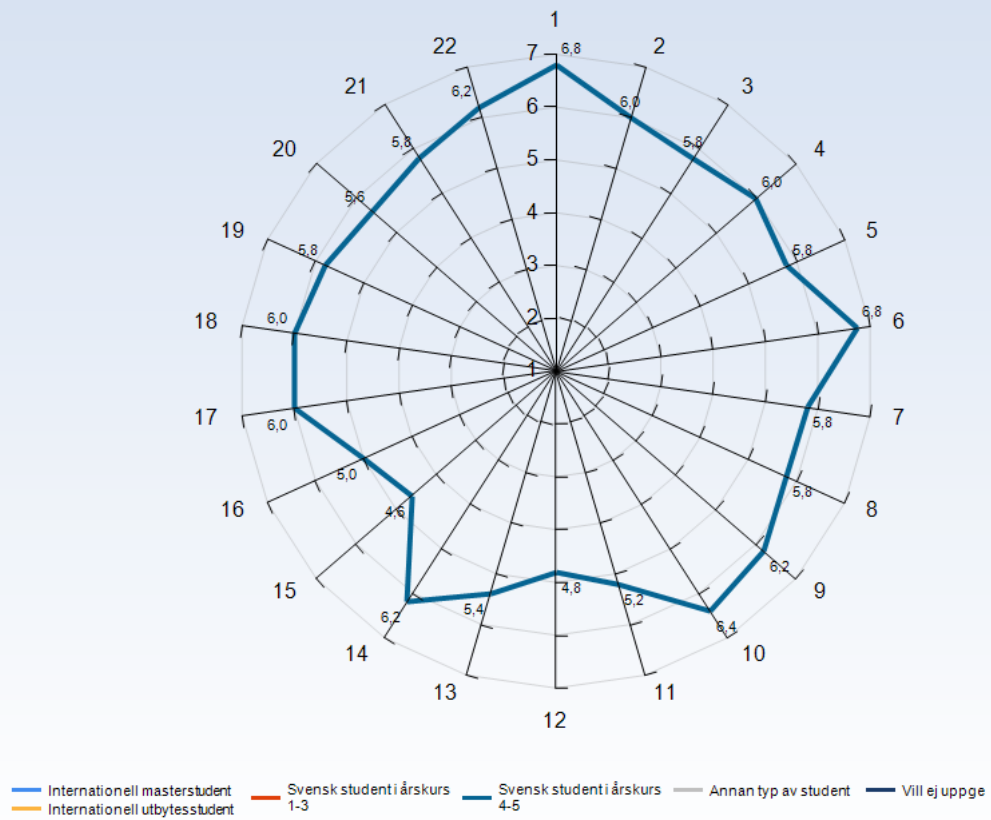


Average response to LEQ statements - all respondents per gender



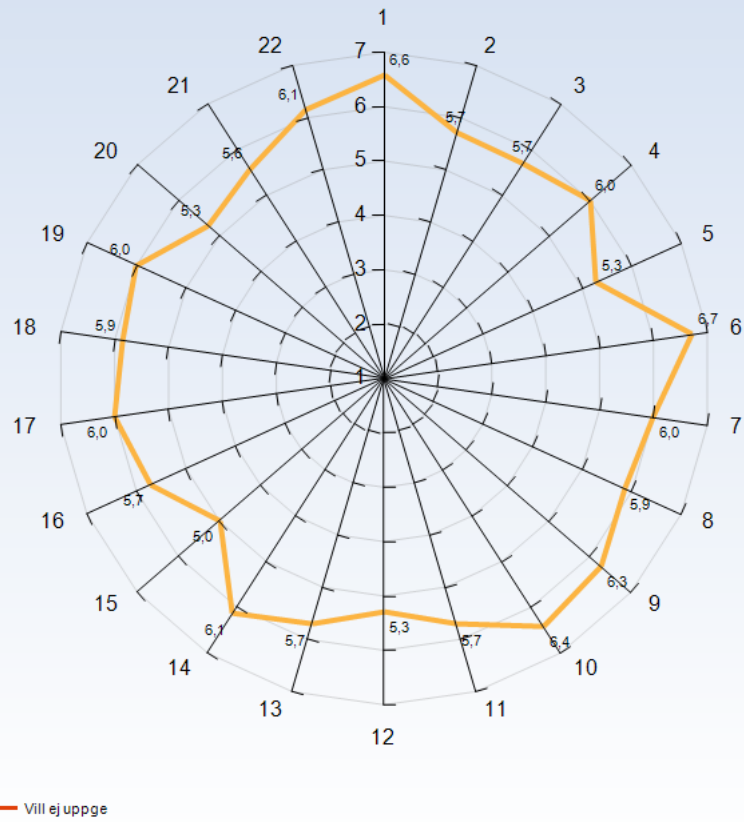
Comments

Average response to LEQ statements - all respondents per type of student



Comments

Average response to LEQ statements - all respondents per disability



Comments



GENERAL QUESTIONS

What was the best aspect of the course?

What was the best aspect of the course? (I belonged to: Grupp 1)

Varying problems, helpful teachers

What was the best aspect of the course? (I belonged to: Grupp 2)

The classroom problems were the best part of the course. It was intriguing.

What was the best aspect of the course? (I belonged to: Grupp 4)

That the teachers were so helpful. They really cared if we did not understand something, and spent a lot of time to help us. I found the course very challenging, but since the teachers were so helpful that was all right.

What was the best aspect of the course? (I belonged to: Grupp 5)

The problems were very concrete and relevant for future work in chemical engineering.

What was the best aspect of the course? (I belonged to: Grupp 6)

The home and classroom problems, as well as the computer assignments, helped a lot with understanding different concepts and problem solving strategies.

What was the best aspect of the course? (I belonged to: Grupp 7)

I really enjoyed the group assignments, they were invaluable for learning! The lectures were also very good and pedagogical with an inclusive atmosphere

What would you suggest to improve?

What would you suggest to improve? (I belonged to: Grupp 1)

At times I felt overwhelmed by the amount of submissions we needed to do. So a schedule over all submission before hand would have been nice to be given.

What would you suggest to improve? (I belonged to: Grupp 2)

The interaction with other groups during problem solving would have been better

What would you suggest to improve? (I belonged to: Grupp 4)

The scheduling. Way too many assignments (labs, home problems and classroom problems) at the end of the course. The assignments should be spread out more evenly. Of course it is difficult to do the assignments before going through the material in the lectures, but if there were more lectures in the beginning of the course, the assignments could get started earlier. It should be possible to complete all assignments well in advance of the exam period, so that we can focus on studying for the exam as well as getting feedback.

For the classroom problems and labs, it would be helpful if they could be published the day before (or even a few hours before) the scheduled zoom-session. Then the students have time to understand the problem, and can spend the zoom-session to ask questions and not just get started. This happened a few times, and it made a huge difference to have time to check the results with the teacher to make sure that you had understood everything. More time efficient for everyone.

What would you suggest to improve? (I belonged to: Grupp 5)

The exam, cutting time in half while doubling/maintaining amount of work is nit reasonable

During the lectures, work on more examples with different situations and explain better how to adapt the examples to the situation. Since there are a lot of different formulas in the course, it was sometimes difficult to determine which one we can use in what situation and I think that is very confusing if it is not explained well. Also, after having submitted the classroom problems, labs or home problems, I think it would be very useful to give a detailed correction on how to solve the problems. We were left with only a grade and some comments on what was wrong but no real correction, so it was hard to assimilate the learning outcomes and be able to correct the mistakes.

What would you suggest to improve? (I belonged to: Grupp 6)

Maybe more time for the classroom problems, or upload them the day before. Most of the time, the problems would take significantly longer than 2 hours.

What would you suggest to improve? (I belonged to: Grupp 7)

I think that the lecture about non-ideal reactors could be made into two lectures with more calculated examples as it was very central to the course. Furthermore, highlight aspects of the course that are important but not included in assignments throughout the course so that one has a chance to study this before the exam.



What advice would you like to give to future participants?

What advice would you like to give to future participants? (I belonged to: Grupp 1)

The book is very helpful in many aspects. MATLAB/other simulation software skills are recommended if you want to solve the problems in the labs and the home problems effectively.

What advice would you like to give to future participants? (I belonged to: Grupp 2)

Have strong basics before you attend the course and practice more MATLAB

What advice would you like to give to future participants? (I belonged to: Grupp 4)

Start the assignments as soon as they are published, they take a lot of time.

Ask the teachers for help, they are very nice and will help you a lot.

For the exam: there is very little time, so make sure you practice speed when studying for the exam.

What advice would you like to give to future participants? (I belonged to: Grupp 5)

Read the book on your own while doing the course to understand better what is happening. I would also advise to do a lot more examples from the book to train, however if this not be only course you are taking, this might be difficult because of the workload this course demands already.

What advice would you like to give to future participants? (I belonged to: Grupp 6)

Read the book :)

What advice would you like to give to future participants? (I belonged to: Grupp 7)

Participate actively during the assignments throughout the course - they really help for learning! Also, read the suggested chapters in the Fogler book, everything is so well explained there.

Is there anything else you would like to add?

Is there anything else you would like to add? (I belonged to: Grupp 1)

No

Is there anything else you would like to add? (I belonged to: Grupp 2)

NO

Is there anything else you would like to add? (I belonged to: Grupp 5)

While I felt the course included interesting topics and information the overall workload was way to high. Spending 30-40h a week on a single course should not be required. These work times were mainly due to the honeproblems.

Is there anything else you would like to add? (I belonged to: Grupp 7)

Thank you for a very interesting course! I've really enjoyed it!

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

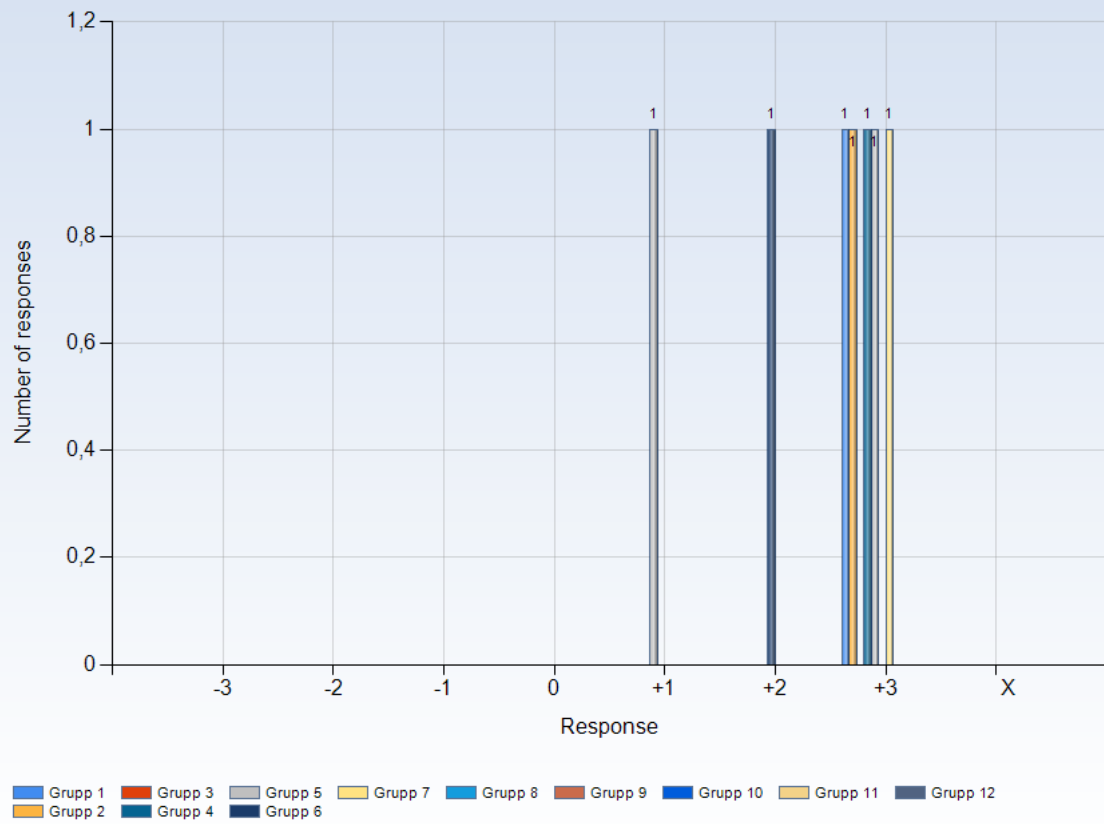
0 = I am neutral to the statement

+3 = Yes, I strongly agree with the statement

X = I decline to take a position on the statement

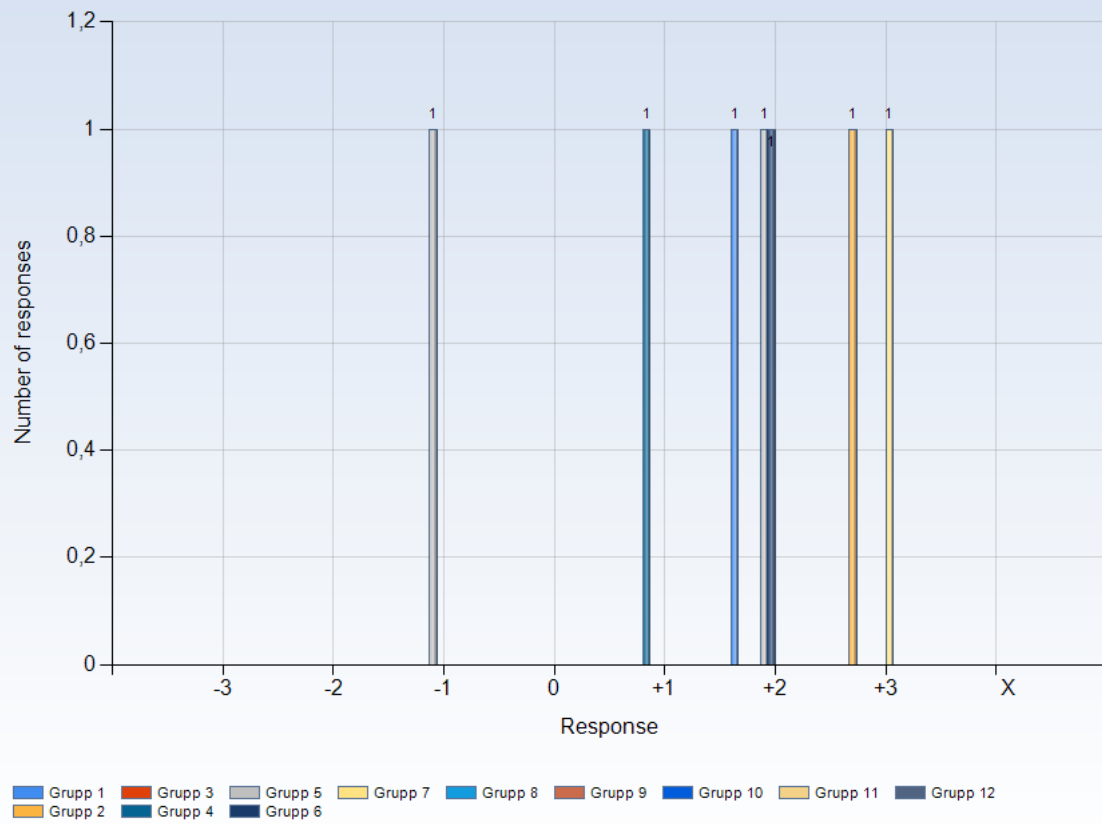
Note! If you want to compare the results between different groups on equal terms, you must normalize the number of responses with the size of the corresponding group. The size of each group is found in the first diagram in this report.

1. I worked with interesting issues



Comments

2. I explored parts of the subject on my own

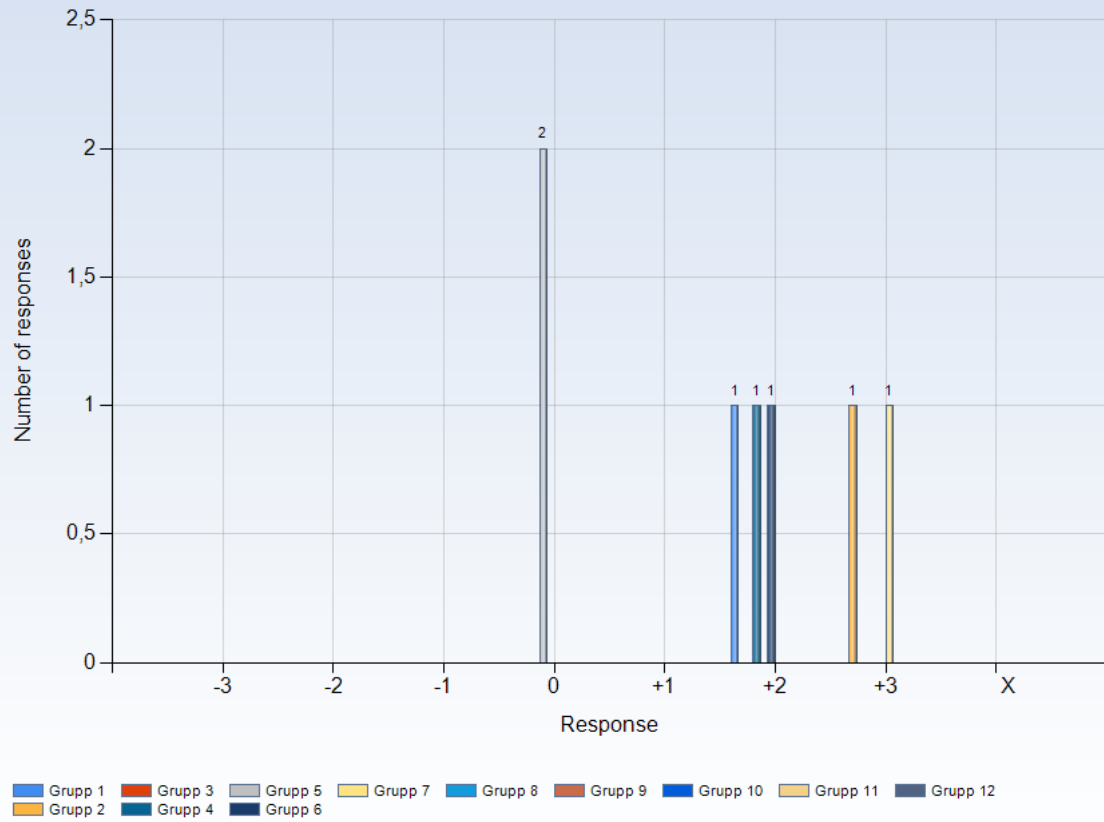


Comments

Comments (I belonged to: Grupp 7)

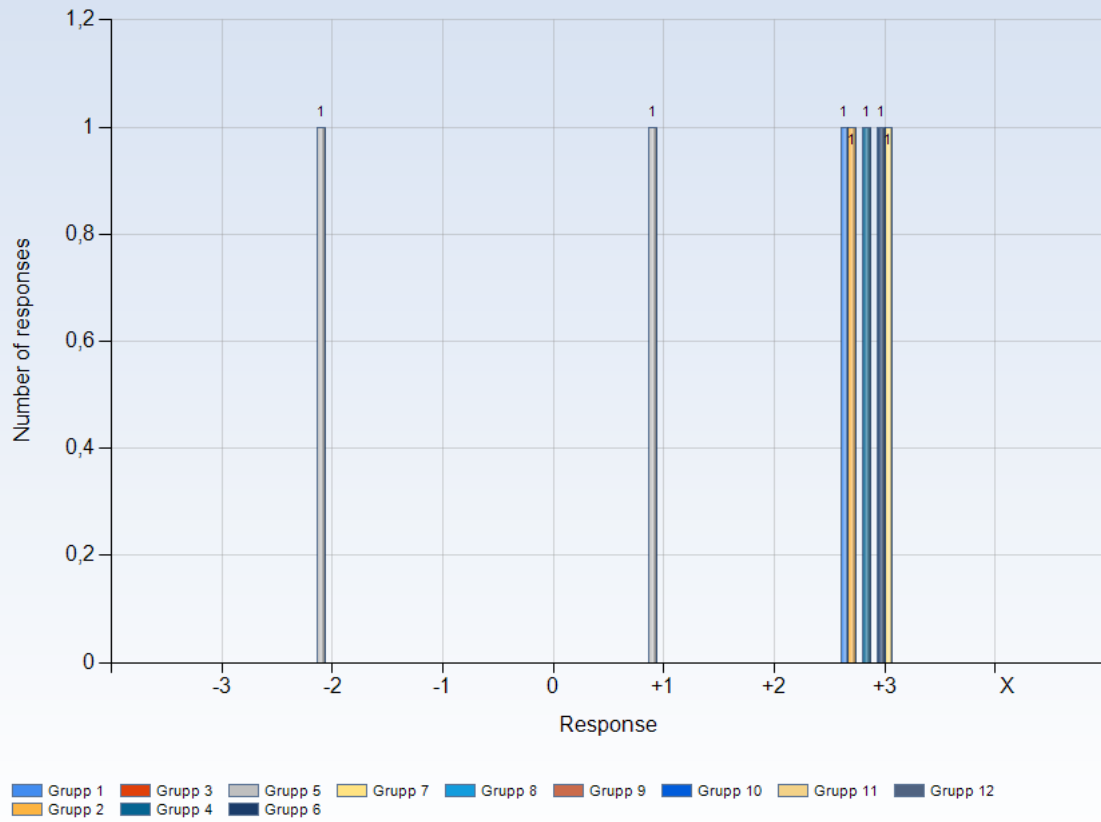
The course literature is amazing!

3. I was able to learn by trying out my own ideas



Comments

4. The course was challenging in a stimulating way



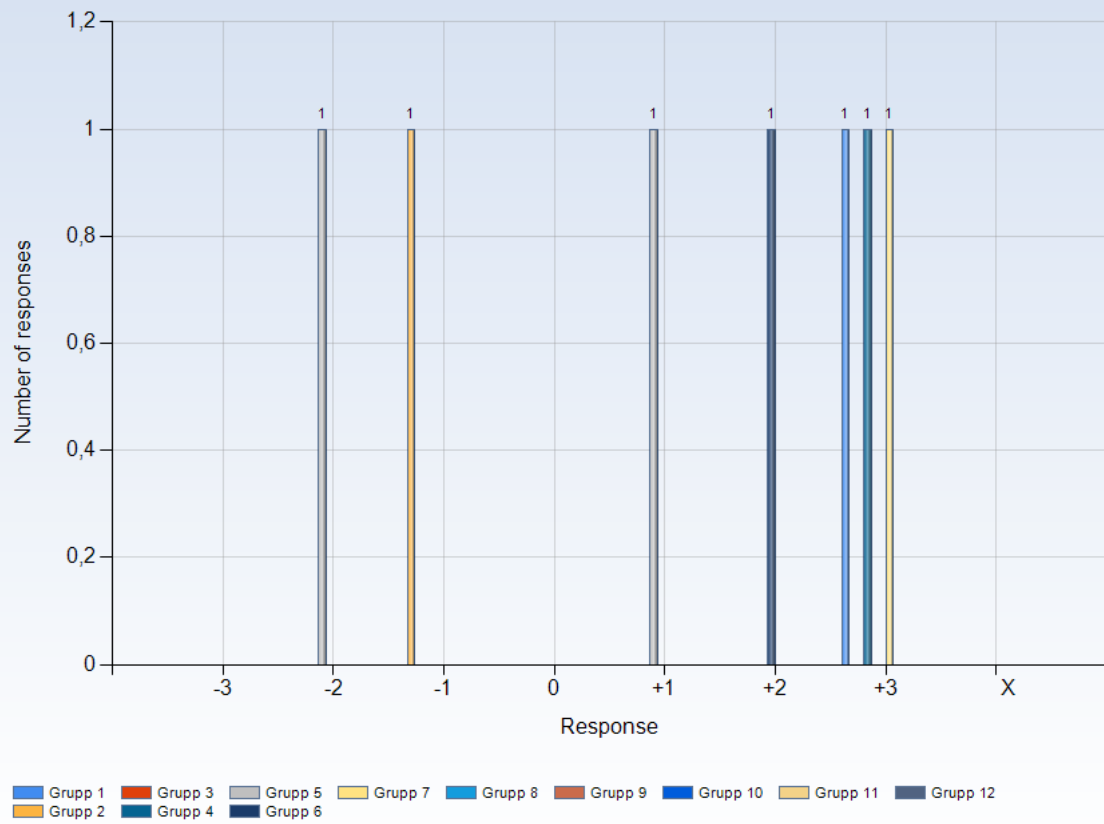
Comments

Comments (I belonged to: Grupp 5)

The course was challenging mainly because of excessive workload

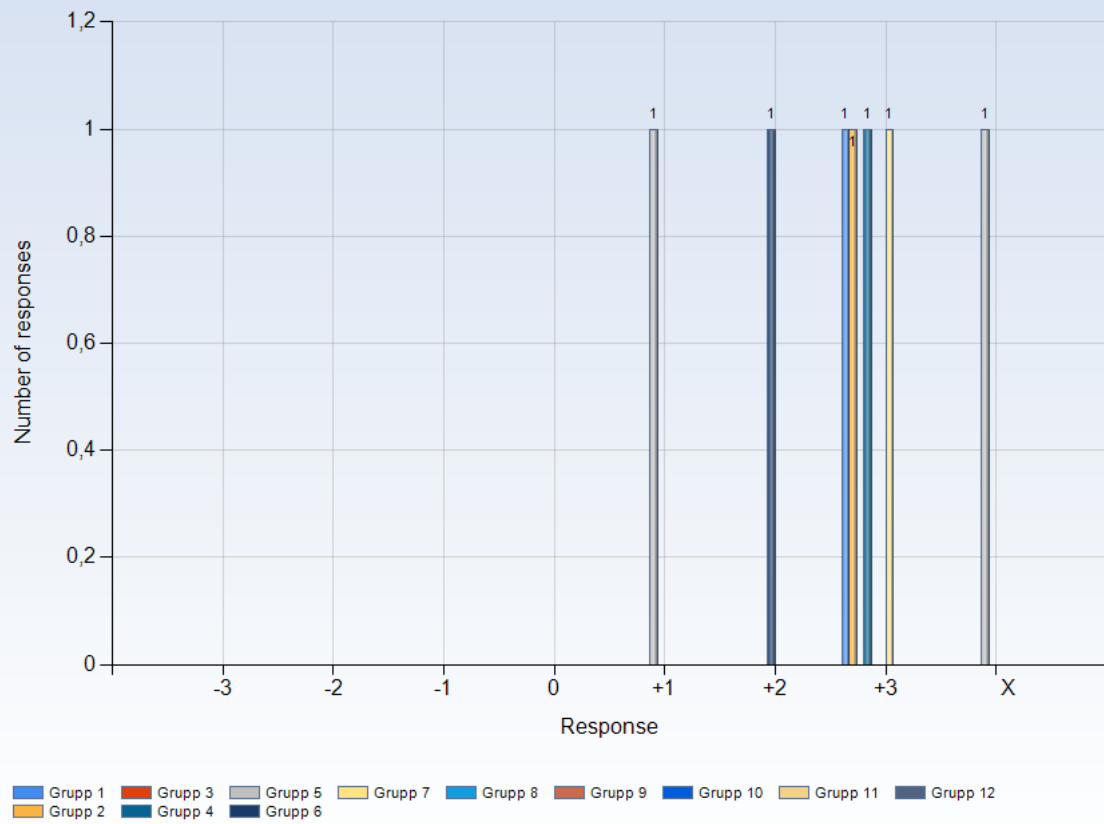
The course was sometimes difficult to follow and the problems given involved situations that were completely new and were not taught in class, which made it too challenging, in particular when this was not the only course in the period.

5. I felt togetherness with others on the course



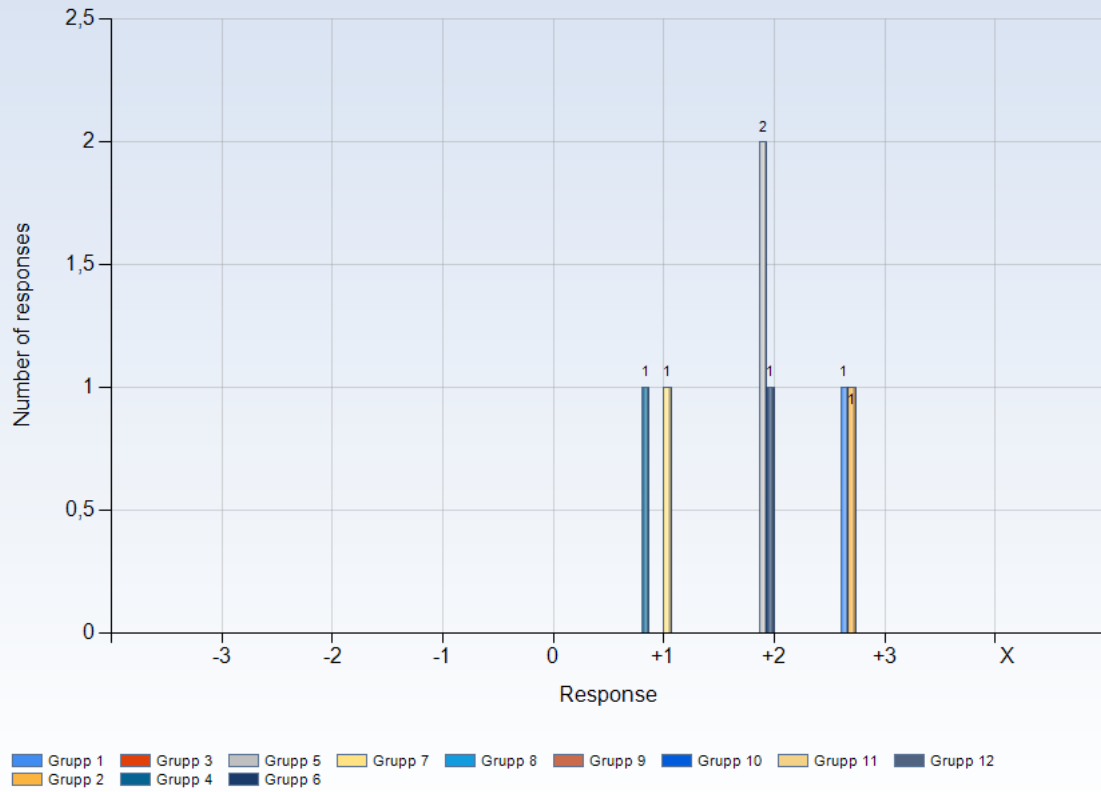
Comments

6. The atmosphere on the course was open and inclusive



Comments

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

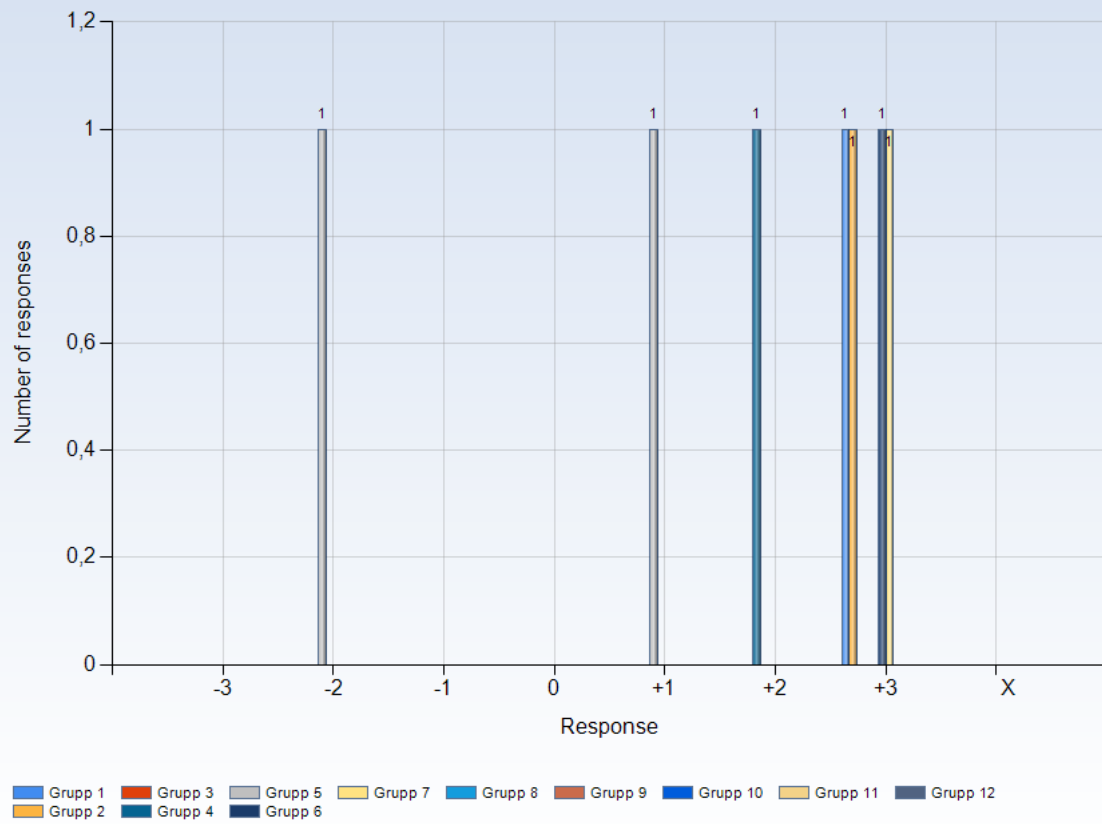


Comments

Comments (I belonged to: Grupp 7)

It would be helpful to specify the learning objectives a little more clearly in the course PM. Another alternative would be to highlight the study guide as it is very thorough

8. The course was organized in a way that supported my learning

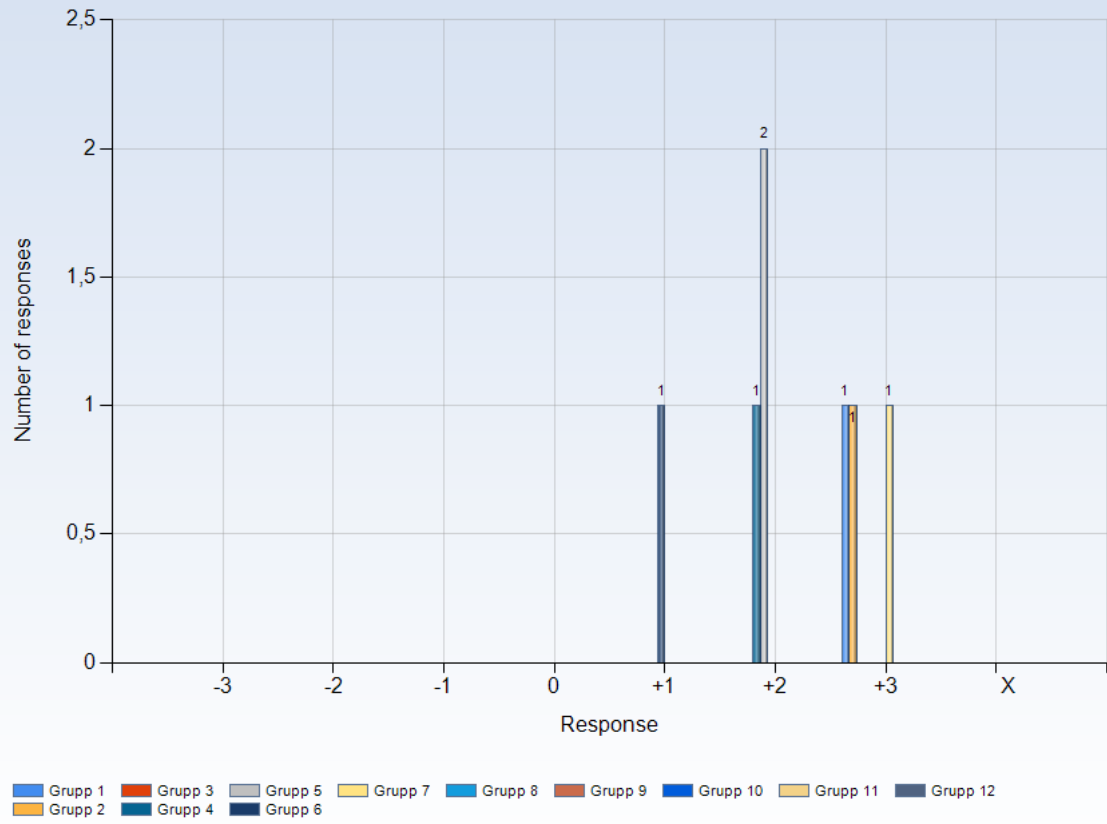


Comments

Comments (I belonged to: Grupp 5)

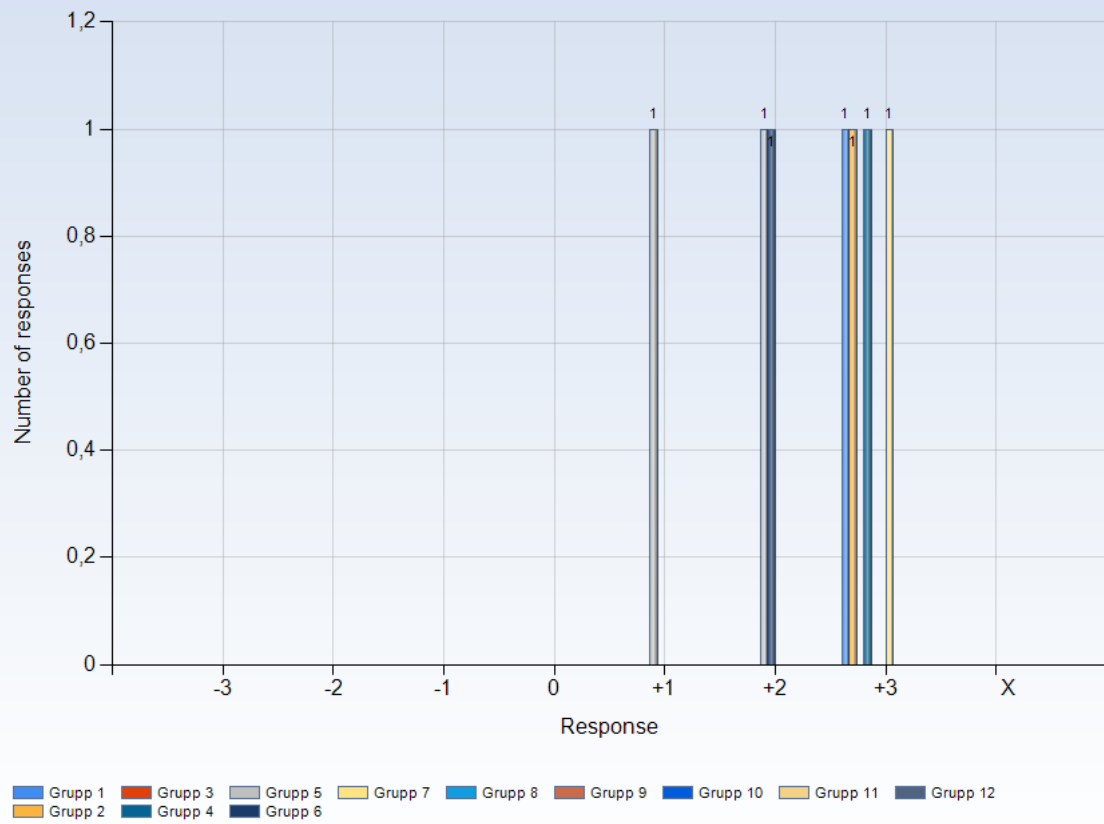
There was too many classroom and home problems with short deadlines and no feedback before being graded.

9. I understood what the teachers were talking about



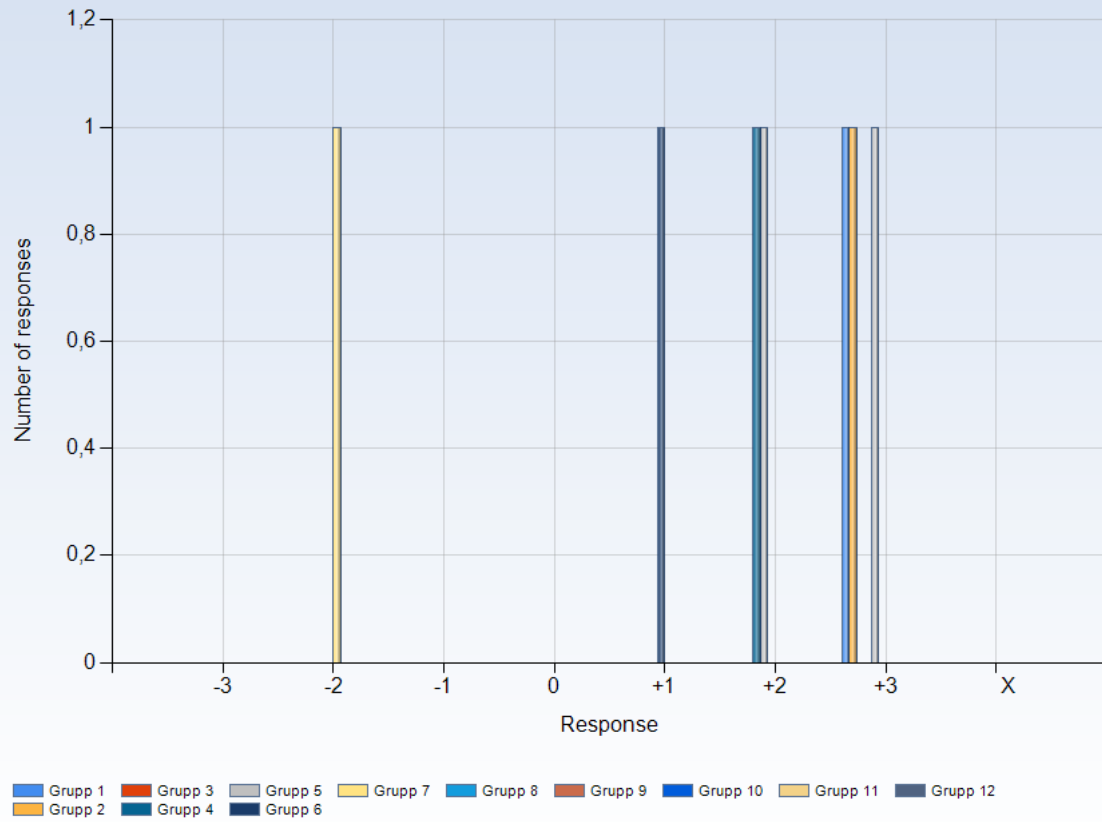
Comments

10. I was able to learn from concrete examples that I could relate to



Comments

11. Understanding of key concepts had high priority

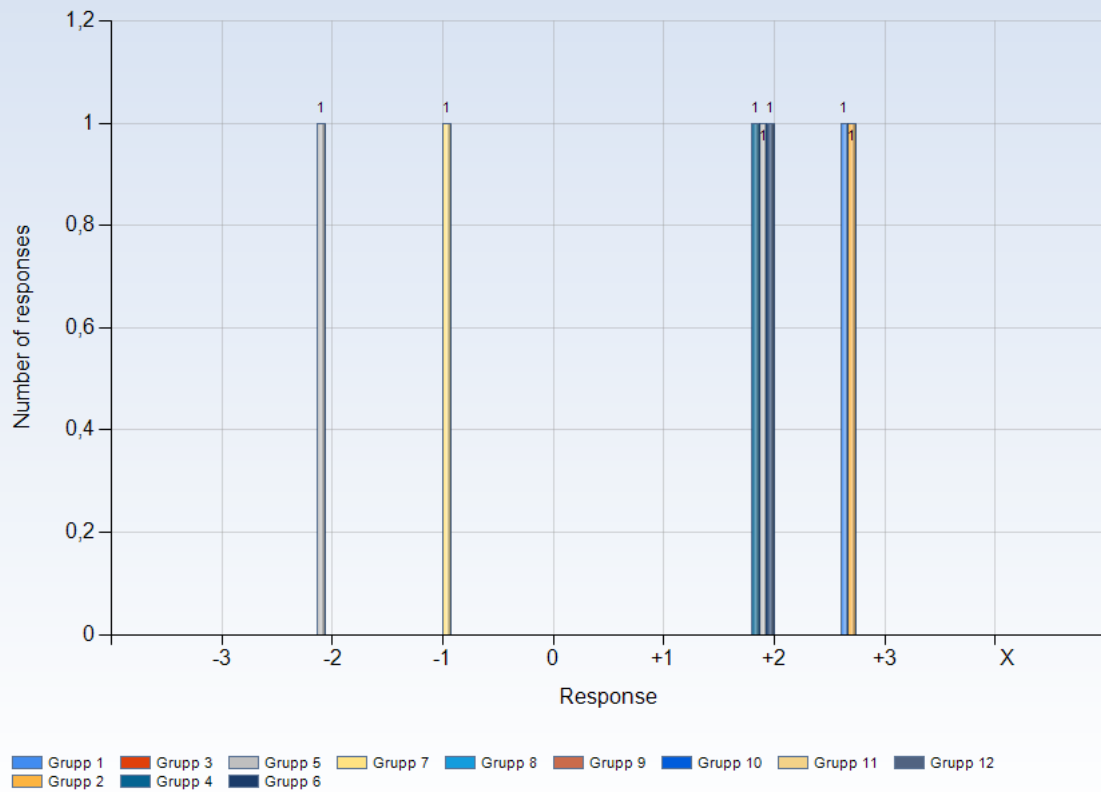


Comments

Comments (I belonged to: Grupp 7)

Considering the exam, a lot of questions were regarding topics that we had never calculated. Of course, they were mentioned during lectures and the study guide but they did not appear as central to the course as other topics since we had no previous assignments on this. As a suggestion, the teachers could perhaps highlight what is important to study beyond the assignments.

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



Comments

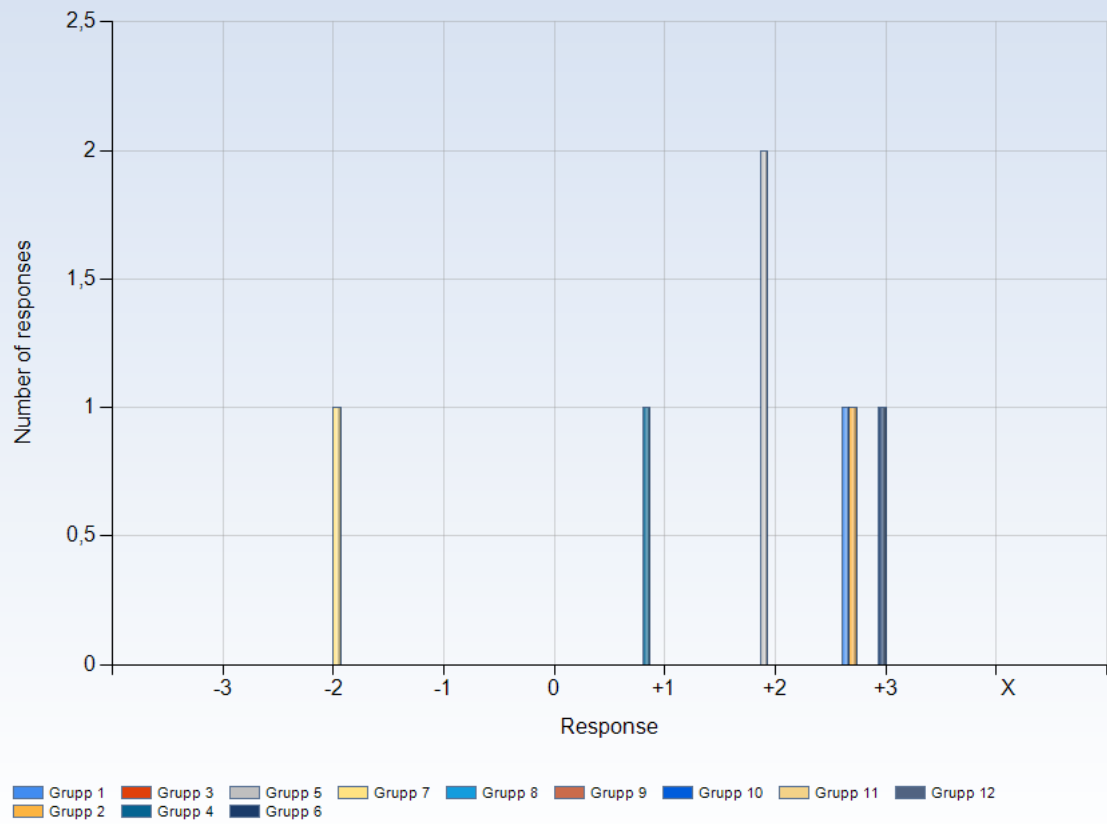
(I belonged to: Grupp 5)

All home problems were massively oversized

(I belonged to: Grupp 7)

As mentioned, I felt like I really understood the course well until the exam where very different topics appeared. See other comment about highlighting other important topics to study ourselves.

13. I understood what I was expected to learn in order to obtain a certain grade

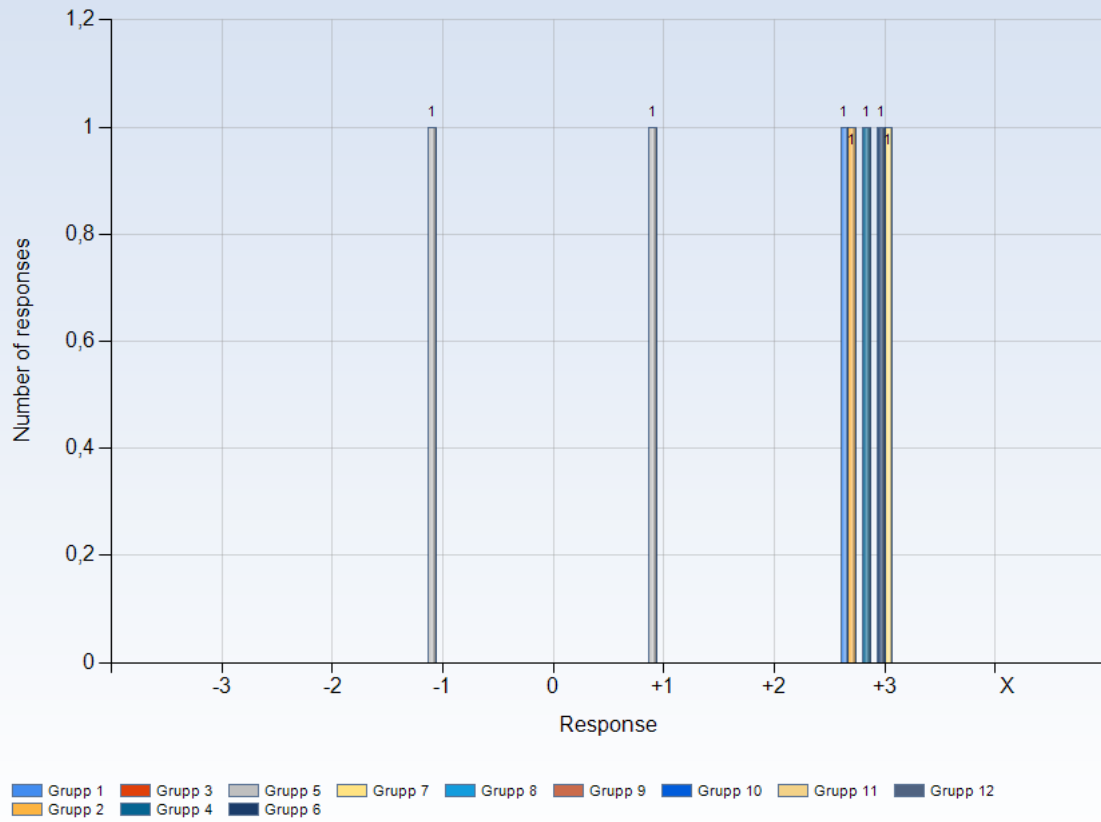


Comments

Comments (I belonged to: Grupp 7)

[See other comments about the exam](#)

14. I received regular feedback that helped me to see my progress

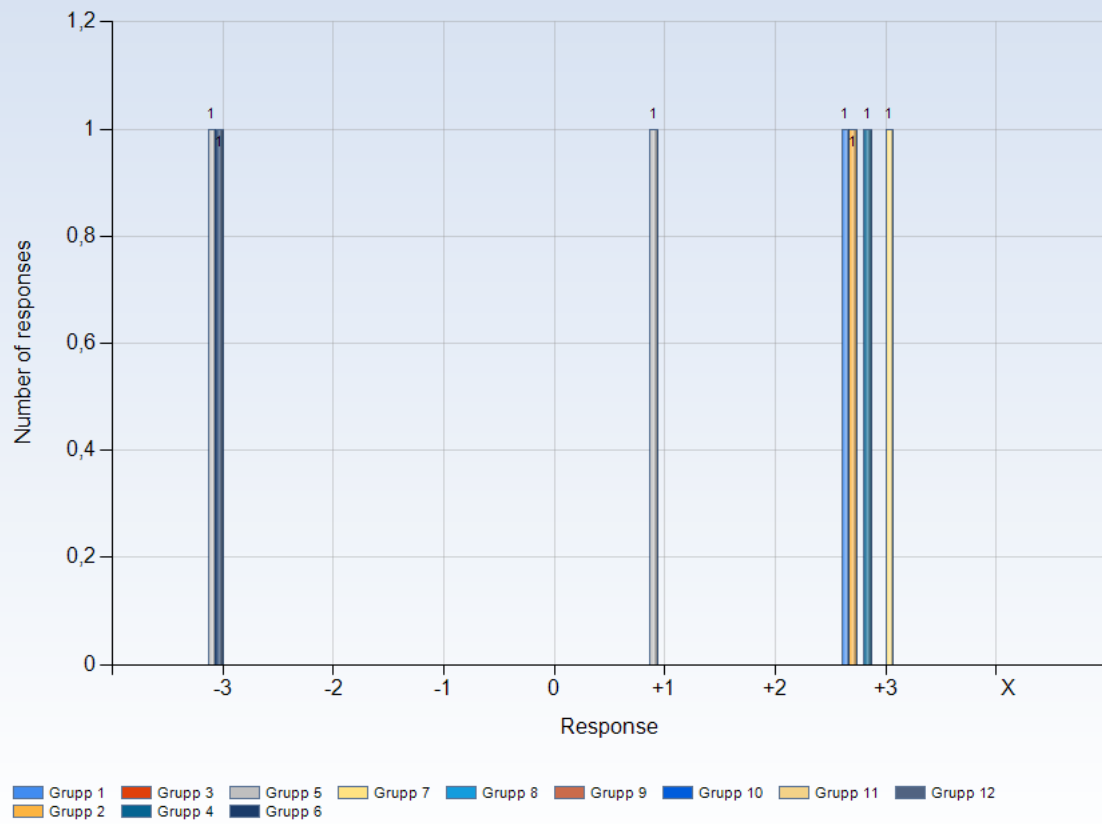


Comments

Comments (I belonged to: Grupp 5)

Even though the teachers and assistants were here to help and answer our questions, it was sometimes hard to get enough help on some of the problems (homework problems) when we were lost.

15. I could practice and receive feedback without being graded

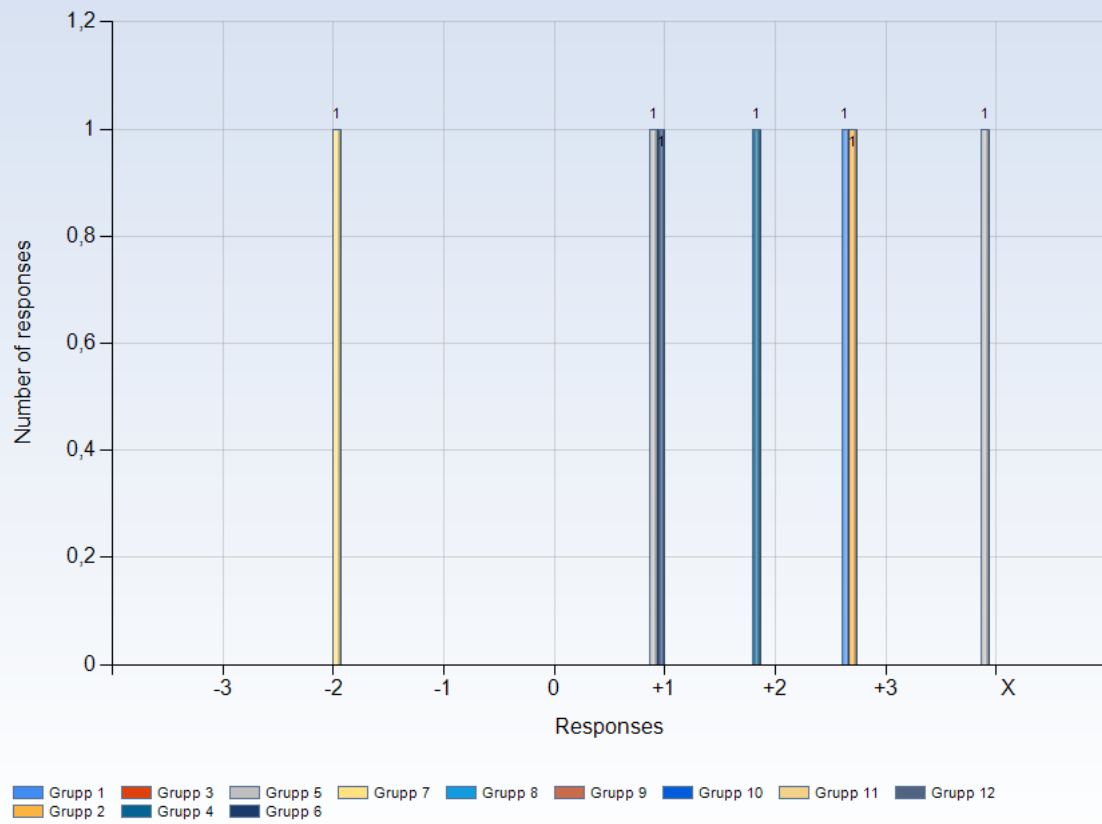


Comments

Comments (I belonged to: Grupp 5)

Feedback on home problems without being graded was not given.

16. The assessment on the course was fair and honest

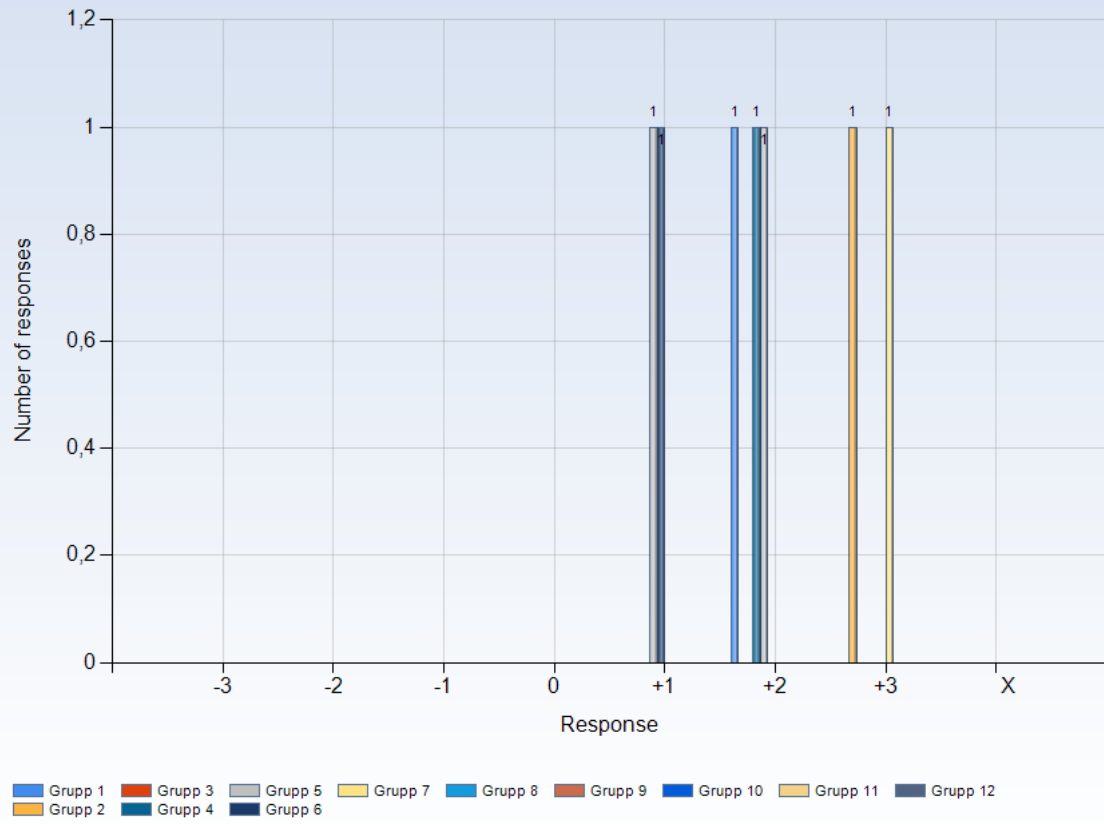


Comments

Comments (I belonged to: Grupp 7)

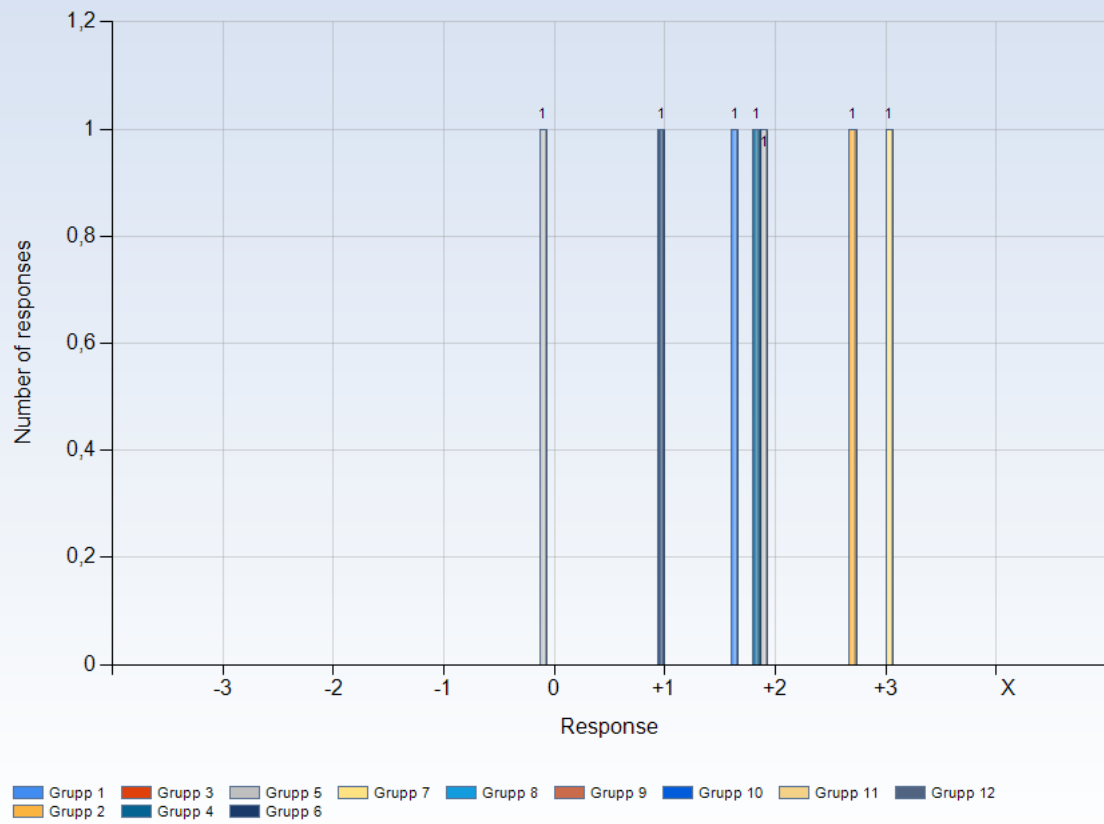
See other comments about content on the exam.

17. My background knowledge was sufficient to follow the course



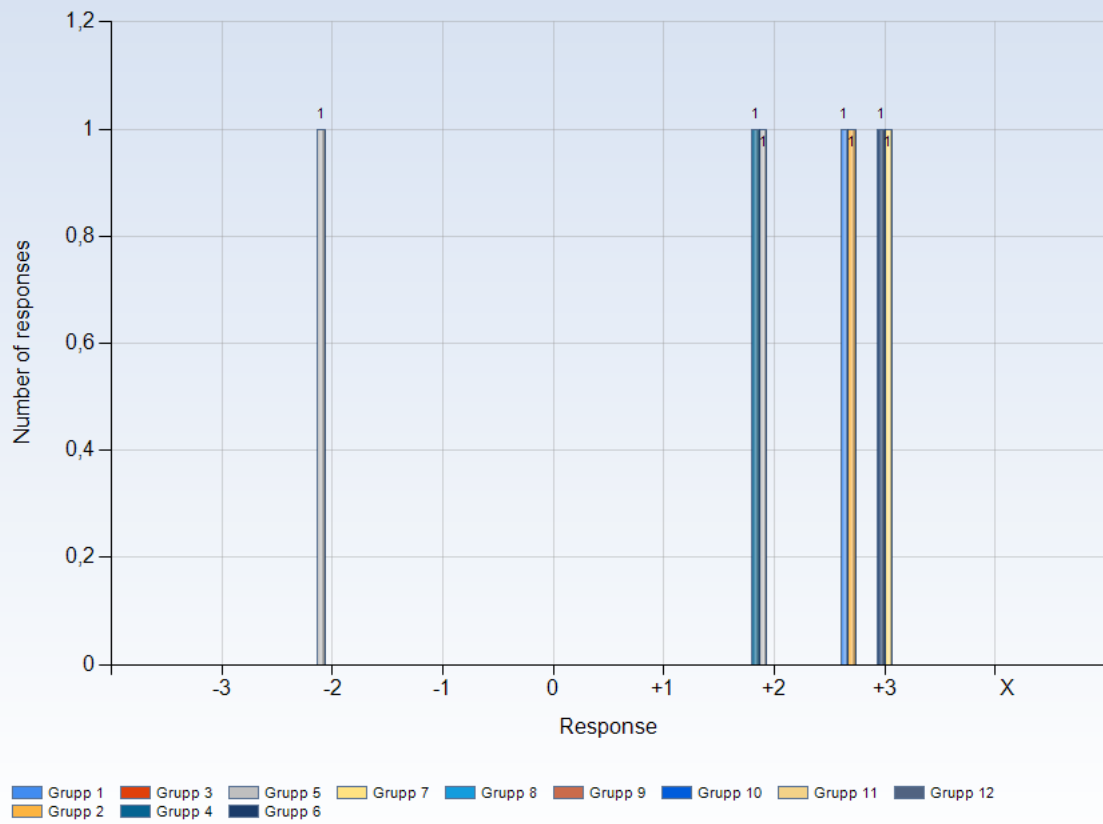
Comments

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



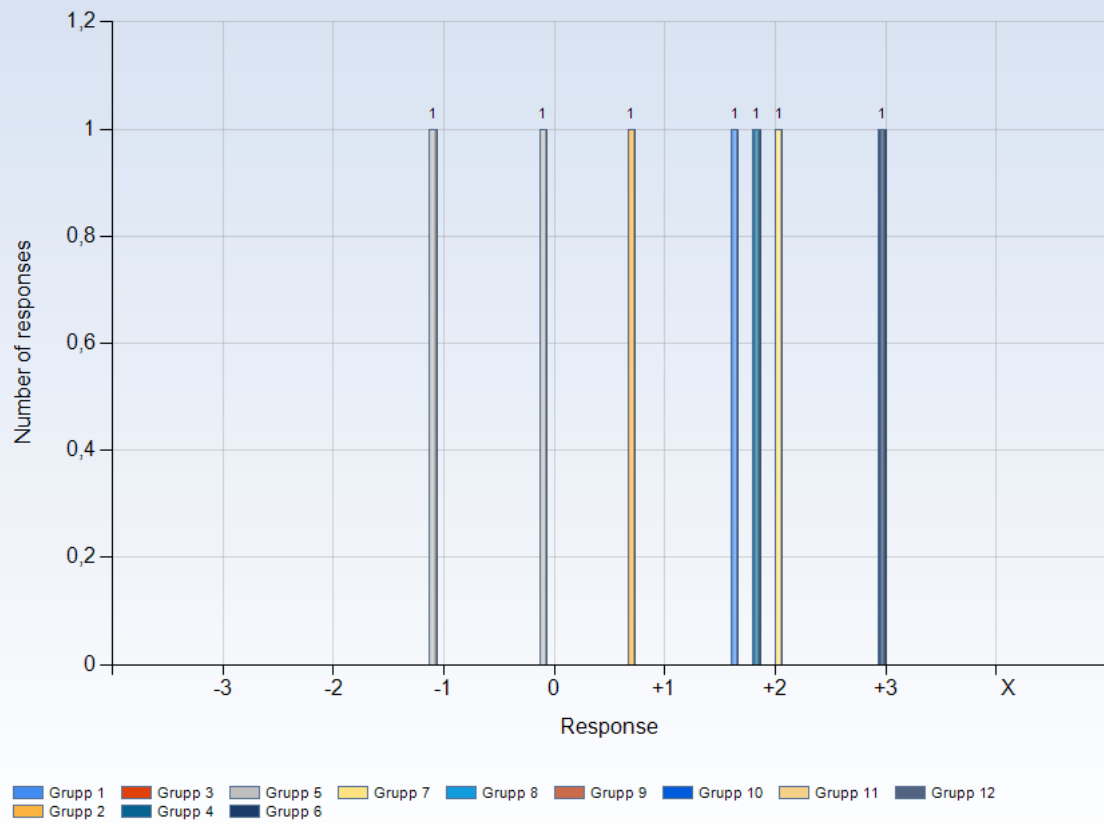
Comments

19. The course activities enabled me to learn in different ways



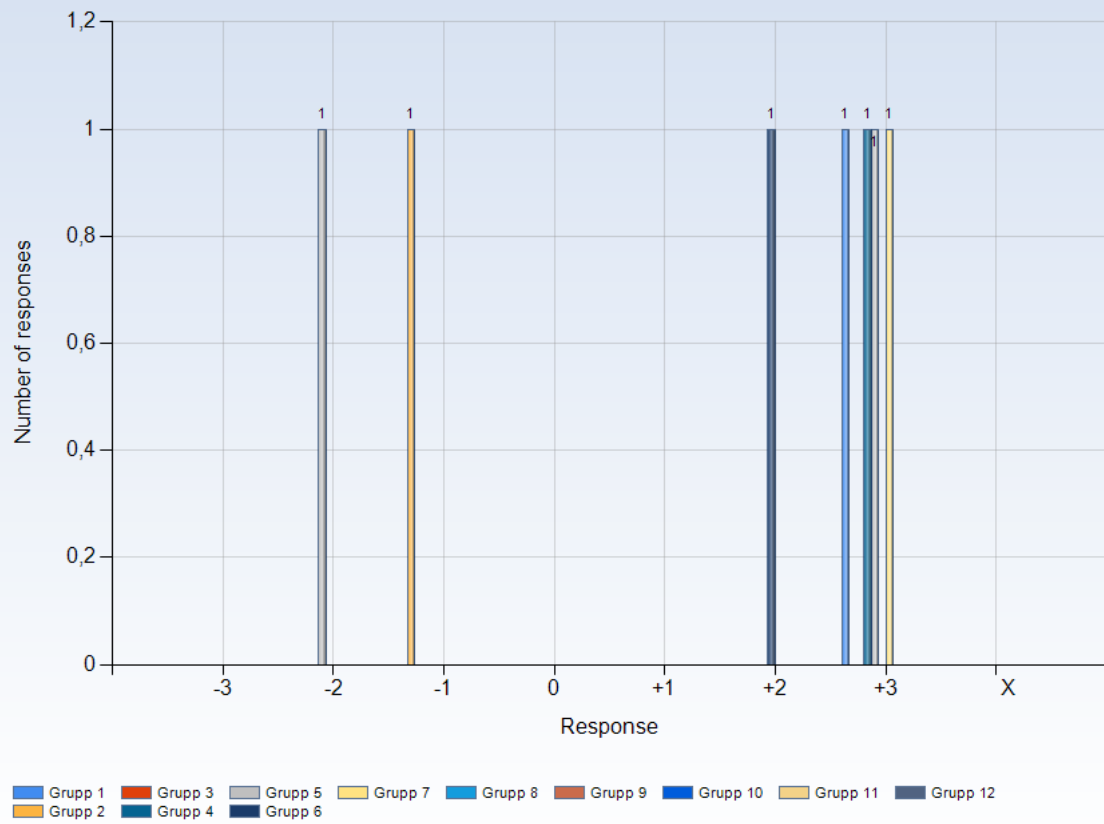
Comments

20. I had opportunities to influence the course activities



Comments

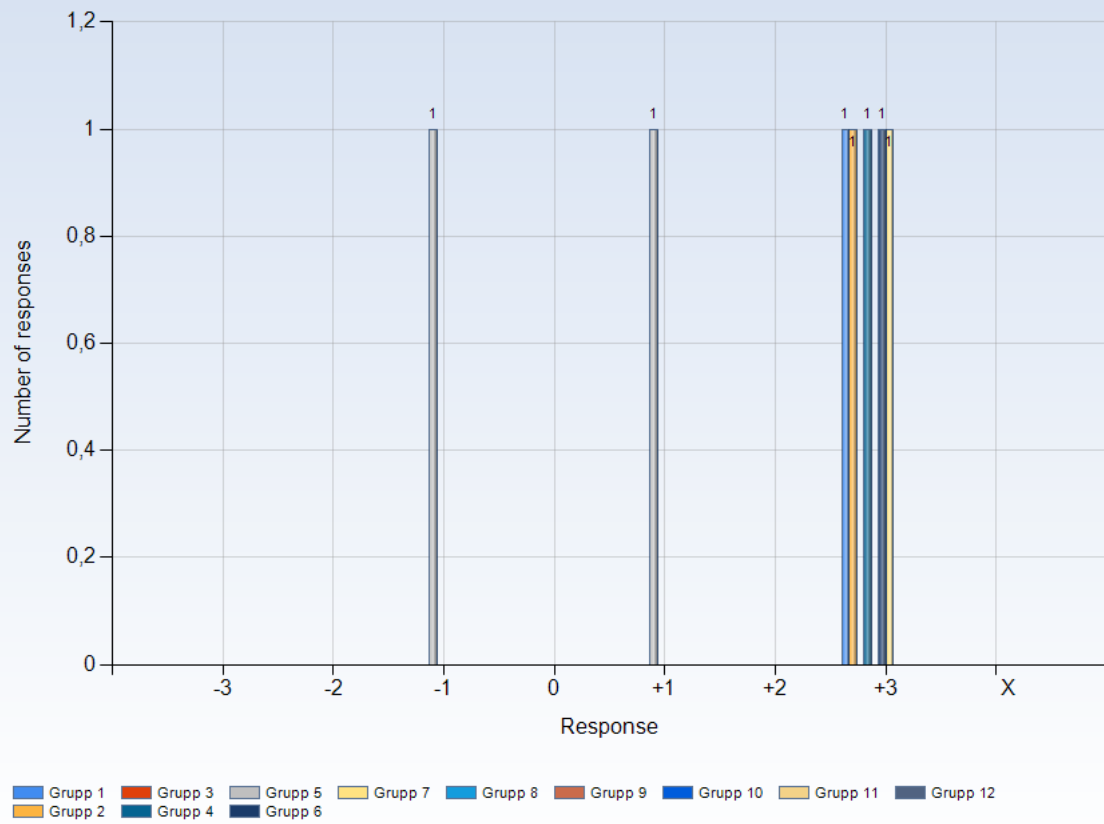
21. I was able to learn by collaborating and discussing with others



Comments

Comments (I belonged to: Grupp 5)
Corona

22. I was able to get support if I needed it



Comments