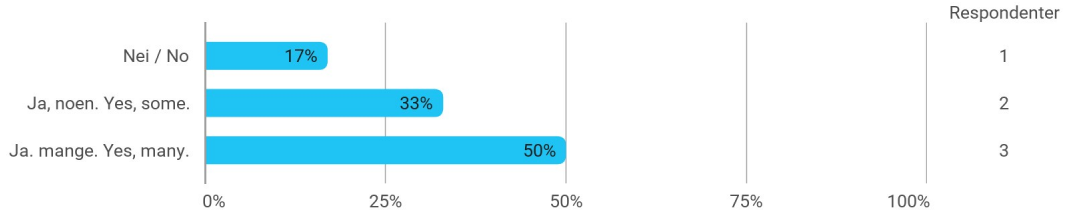
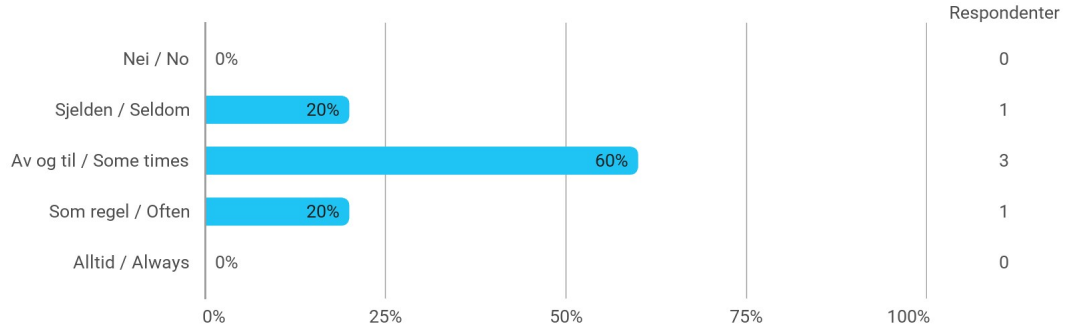
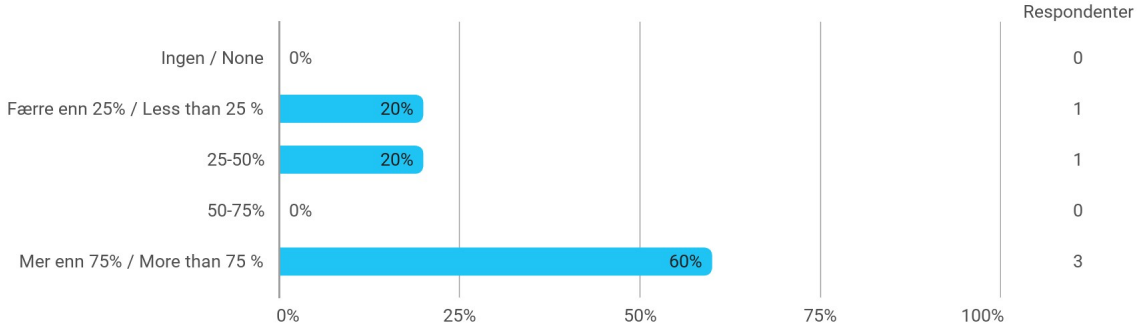
Merket du at du manglet nødvendige matematiske ferdigheter for å ta kurset? / Did you feel that you lacked necessary mathematical skills to take the course?

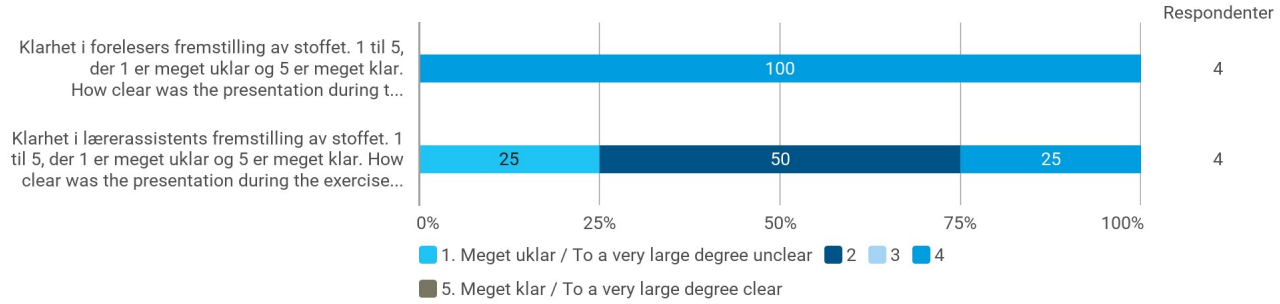


Har du forberedt deg til forelesningene?
Did you prepare for the lectures in advance?

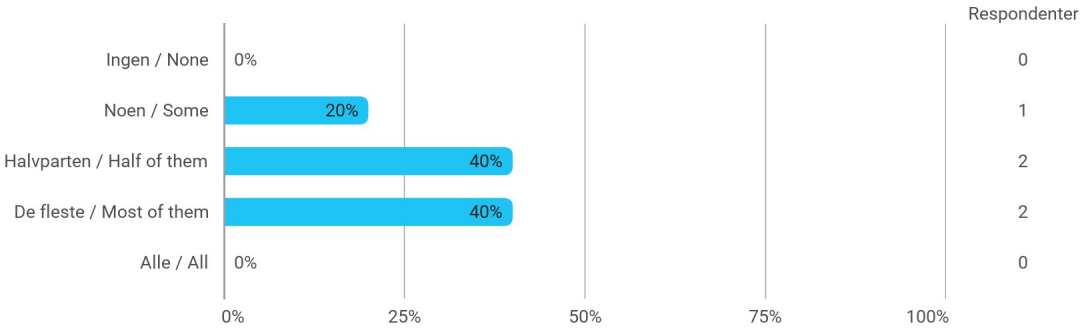


Hvor stor andel av forelesningene har du fulgt?
How many lectures have you attended?

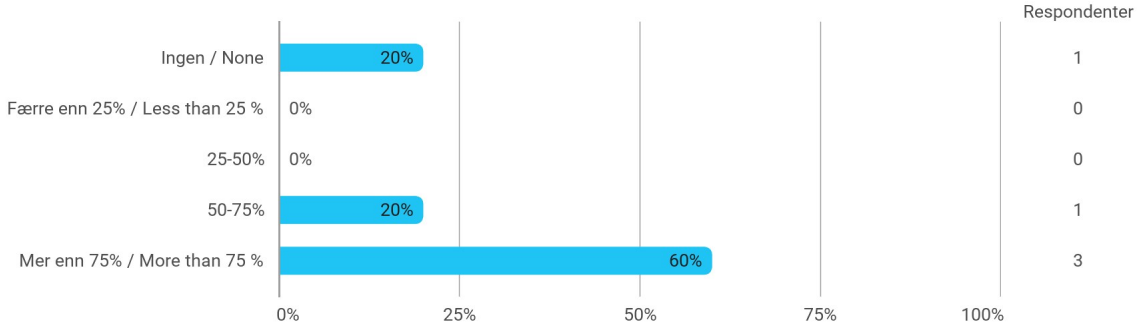




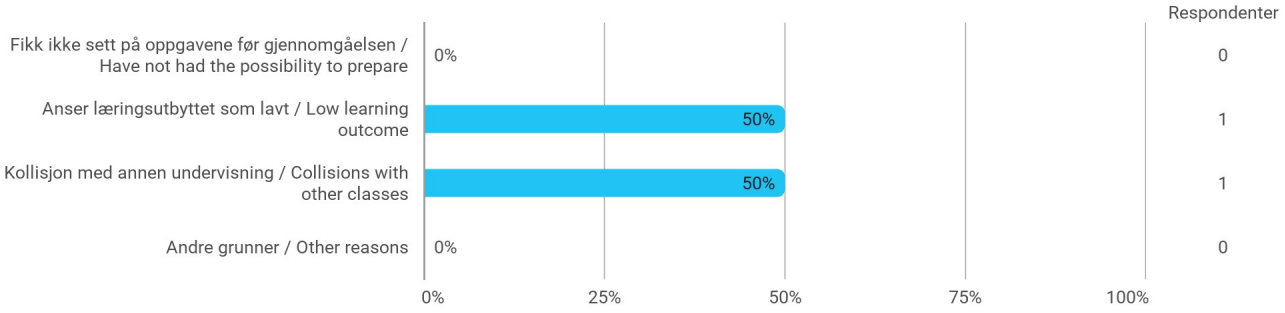
Hvor stor andel av regneoppgavene (kollokvieoppgavene) har du gått gjennom på egenhånd?
How many of the exercises have you done by yourself?



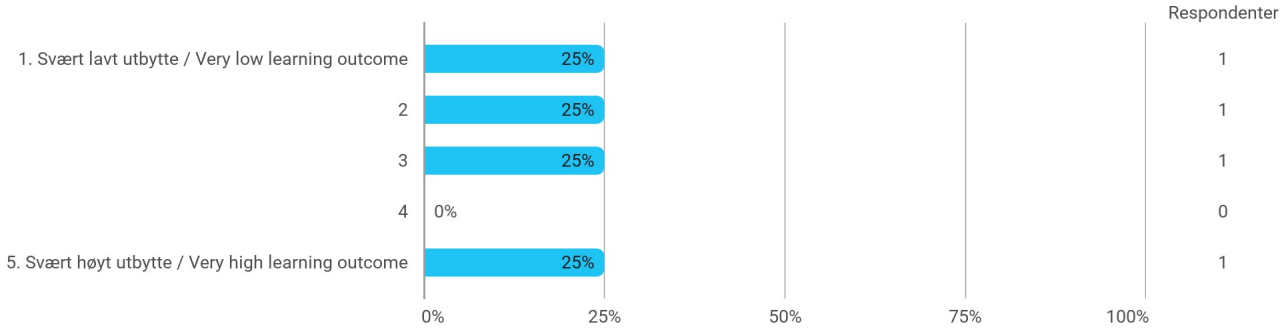
Hvor stor andel av regneøvelsene (kollokviene) har du deltatt i?
How many of the colloquia have you attended?



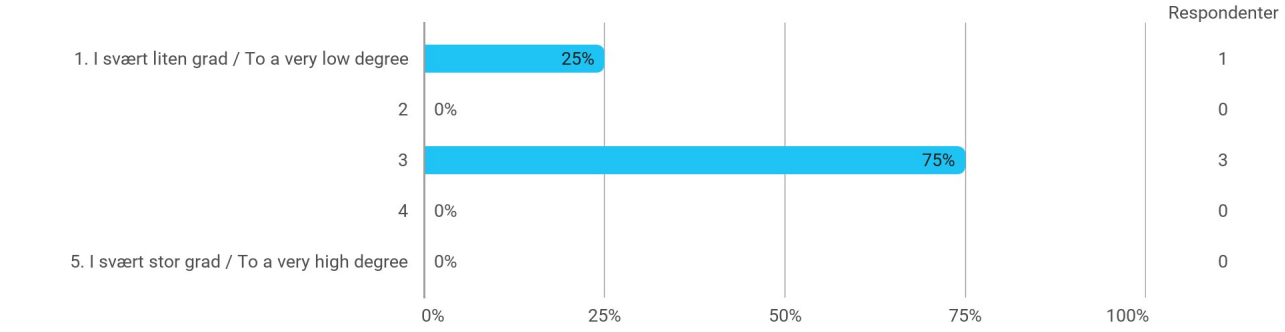
Hva var hovedårsaken til at du ikke deltok på (flere) regneøvelser (kollokvier)?
What is the main reason for not attending more colloquia?



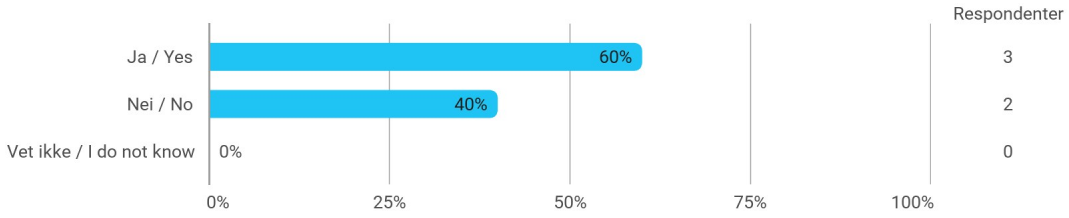
Hvordan har læringsutbyttet av regneøvelsene (kollokviene) vært? 1 til 5, der 1 er svært lavt og 5 er svært høyt læringsutbytte.
How do you rate the learning outcome from the colloquia? Rate from 1 to 5, where 1 is very low learing outcome and 5 is very high learning outcome



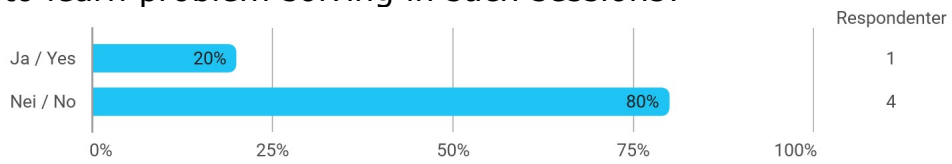
I hvor stor grad lærte du av andre studenter som deltok i regneøvelsene (kollokviene)?
To what degree did you learn from other students that participated in the colloquia?



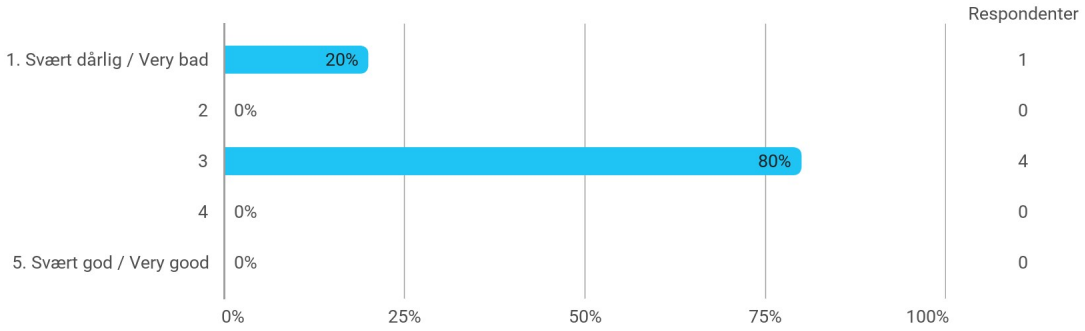
Vi har hatt obligatorisk besvarelse av minst 50% kollokvieoppgavesett i løpet av kurset. Er et slikt obligatorisk element nyttig for læreprosessen?
The hand ins of a minimum of 50% colloquia exercises was mandatory throughout the course. Is this kind of mandatory component constructive for the learning process?



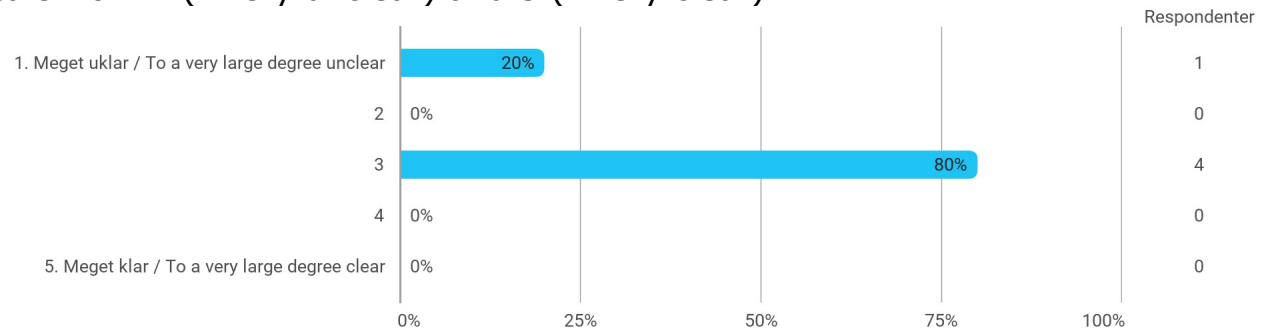
Under kurset var det diskusjon om muligheten for å organisere veiledede økter for problemløsning. Hvis vi klarer å skaffe finansiering for dette, ville du være villig til å være veileder for å hjelpe neste års studenter med å lære problemløsning i slike økter? / During the course there was discussion on the possibility of organizing supervised sessions for problem solving. If we manage to organize funding for this, would you be willing to act as supervisor to help next year's students to learn problem solving in such sessions?

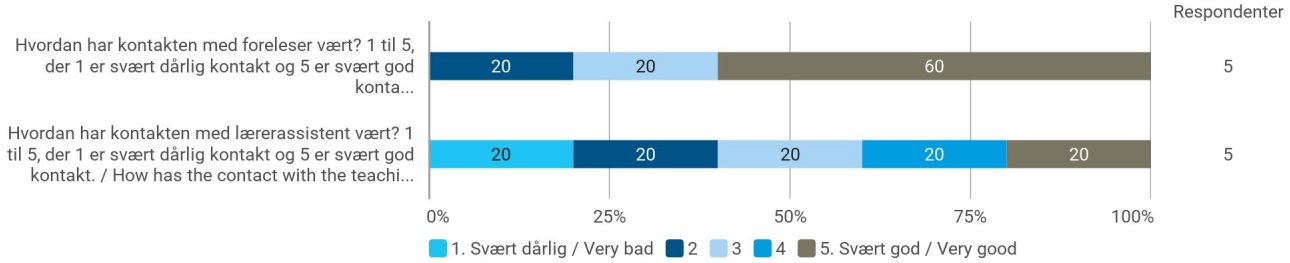


Hva syns du om læreboka? 1 til 5, der 1 er svært dårlig og 5 er svært god. What is your opinion of the textbook? Rate from 1 to 5, where 1 is very bad and 5 is very good.

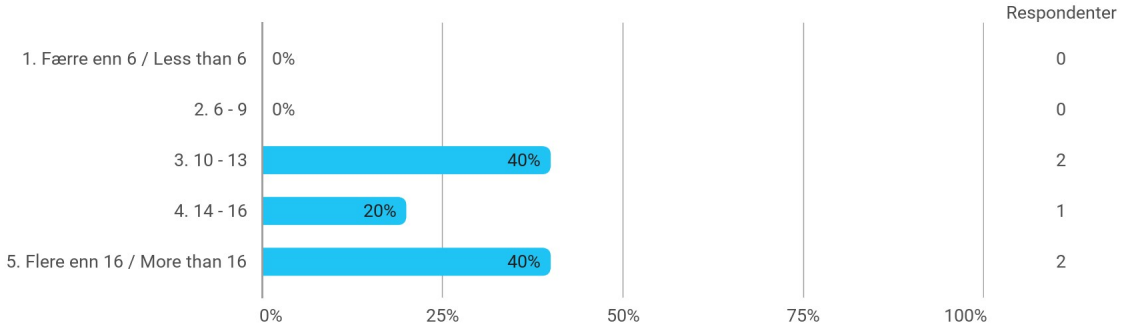


Klarhet i lærebokens fremstilling av stoffet. 1 til 5, der 1 er meget uklar og 5 er meget klar. / How clear was the presentation in the textbook? Rate on a scale from 1 (=very unclear) and 5 (=very clear)





10 studiepoeng skal i snitt tilsvare ca. 13 timer arbeid (organisert undervisning + egenaktivitet) pr. uke. Hvor mange studiepoeng mener du emnet KJEM221 tilsvarer?
How do you rate the work load of this course, given that 10stp corresponds to 13 h work per week?



Evaluation report 2023 autumn term

Course code: KJEM221

Faglærers vurdering av gjennomføring /*lecturer's assessment of implementation*:

Praktisk gjennomføring /*practical implementation*

The course was taught over 14 weeks, with two 2h lectures and one 2h exercise session per week, such that in sum there were 84 hours of contact teaching: 56 hours of lectures and 28 hours of exercises.

The lectures were held by Prof Dr Markus Miettinen and exercises by Mr J. Enrique Aguilar Martinez.

To write the exam, students were required to solve (in practice: to have seriously worked on) half of the exercise problems on both 7-week halves of the course. To check this, the students were asked in the beginning of each exercise session to mark the exercise problems they had solved. During the session they were then asked to present on the board some of the problems they had marked. Such an approach is successfully used in other countries, such as Finland and Germany, to encourage students to seriously think and solve problems on their own, which is absolutely key to learning Quantum Mechanics (QM).

Strykprosent og frafall /*failure rate and dropout*

18 students registered for the course, out of which 13 took the exam (dropout rate: 28%), and 11 passed it (failure rate: 15%).

Note: The dropout rate may be somewhat misleading, as many of the 18 registered students had already gained the right to write the exam in the previous years (the right holds for five semesters), and these students seemed to not take part in teaching. A better indicator of the 2023 students' dropout is the number of students doing the exercises: Of the 11 students that worked on more than one exercise session, all 11 gained the right to write the exam. Hence, the dropout rate in this pool appears to be 0%.

That said, among these 11 the distribution of was clearly bimodal: Whereas 2 of them solved more than 75% of the exercise problems, the remaining 9 struggled to reach the 50% required. Interestingly, the top-2 had received their schooling abroad, the bottom-9 in Norway. Indeed, it was clear during the course that the student pool is struggling with the mathematics necessary to learn QM. For example, they were not *a priori* comfortable dealing with such basic concepts as the chain rule and partial integration. This is also reflected in the student-evaluation responses, where 83% of the respondents reported lacking (some (33%) or many (50%) of) the necessary mathematical skills to take the course; among the skills they listed lacking were calculus, especially that of multidimensional functions (MAT212). It is thus not surprising that students find that they are out of depth on the course.

Karakterfordeling /*grade distribution*

The average grade was E. The highest grade was C, after adjusting the scale.

Notably, just one candidate received more than 50% of points on the exam, which was surprising taking into account that the exam contained several questions taken directly from previous year's exam and the exercise problems; this seems to suggest a lack of student motivation that should be addressed in 2024.

Studieinformasjon og dokumentasjon
/*information of studies and documentation*

Information (e.g., the exercise problems and the model answers) was provided through Mitt UiB.

Tilgang til relevant litteratur
/*access to relevant literature*

The students did not mention that the book would not have been available for buying, or for loaning from the libraries.

Faglærers vurdering av rammevilkårene
/*lecturer's assessment of the teaching conditions*

Lokaler og undervisningsutstyr
/*premises and teaching equipment*

The lectures were given in Tripletten and Auditorium 4. Tripletten turned out to be a very poor location, as the lectures use a combination of slides and blackboard, and in Tripletten the canvas for slides covers the blackboards. Auditorium 4, in contrast, worked very well.

For the slides, mentimeter.com was used and found to be rather useful, as it also allowed one to include small quizzes and clicker polls into the lecture. This interactivity allowed reminding students of the previous lecture's key concepts, and keeping them more awake during the lecture.

Andre forhold
/*other conditions*

As discussed above, the students would need tutoring in problem solving in general, not just in QM. To fill this gap in their training is, however, impossible with the available teaching resources—it should have been taken care of over several previous years, probably starting already at the highschool level.

This is unfortunate, as the solving and discussing of problems is the best way to learn QM.

There was discussion during the course, if this issue could be alleviated by hiring a student assistant or two among the 2023 students to help the 2024 batch with problem solving. This could, and probably should, be tried; 20% of the respondents to the student evaluation said that they would be willing to work in such a role.

Faglærers kommentar til student-evalueringen(e)
/lecturer's comments to student evaluation

Metode – gjennomføring
/*method – implementation*

The standard procedure of student questionnaires was followed, and the lecturers were included in designing the questions.

Oppsummering av innspill
/*summary of input*

It is promising that 80% of the responding students say that they prepared for the lectures sometimes or often, as it was stressed to them that in order to be able to follow effectively, one should at least glance through the material in advance.

It is great to hear that 100% of the respondents found the presentation in the lectures to be rather clear (4 in clarity on a scale from 1 to 5 where 5 is 'Clear to a very large degree'). Unfortunately, this positive response contrasts the performance seen in the exam, where some basic concepts discussed repeatedly in class (such as the order of steps to take to solve a QM problem) appeared somewhat unclear to all candidates. This might reflect the perceived clarity of the exercise sessions, where 75% of respondents found the teaching assistant to be (rather (50%) or to a very large degree (25%)) unclear.

The respondents view on their learning outcome from the exercise sessions is somewhat worrying: Only 25% say that they learned a lot from them. In QM, solving the problems actively should be the main way of learning. Promisingly, 60% of the respondents seem to understand and agree with the importance of mandatory problem solving, and most also felt that they learned somewhat from their peers.

In the free comments it was mentioned a few times that the exercise problems were not exam-relevant. This is a surprising statement, as many exam problems were in fact directly from the exercises: Solving just those problems would have given a candidate 50% of the points and resulted in the grade C.

Ev. underveistiltak
/*eventual measures under way*

For 2024, measures should be taken such that the majority of students feel that they learned a lot in the exercise sessions. Possible ways to reach this could be to (1) find a teaching assistant with a Chemistry background (now the lecturer had background in Physics, and the teaching assistant in Mathematics), (2) hire student assistants to help with problem solving, and (3) try to include more of the necessary mathematical background (such as the calculus of many variables) into the curriculum. The point (3) would obviously mean that the actual QM content of the course would need to be reduced.

Faglærers samlede vurdering, inkl. forslag til forbedringstiltak

/lecturer's overall assessment, including suggestions for improvement measures

From the perspective of other universities the lecturer has worked in (in Finland and in Germany), KJEM221 is a rather easy first course in QM. Unfortunately, the Norwegian university students' shockingly poor skill level in mathematics—and problem solving in general—makes it extremely hard for them to understand the logic of QM, and to solve QM problems. To put this in terms of a metaphor: It is great that the students have learned to swim, but as KJEM221 is the equivalent of Advanced Cave Diving II, forcing them to take it is sure to lead to a tragedy.

Against this grim backdrop, KJEM221 was on the whole carried out satisfactorily in 2023. In 2024, the key improvements would be to try and bring the students' mathematics and problem-solving skills to a minimum level that they could benefit from the course. As discussed above, the possible routes to this would be to (1) find a teaching assistant with a Chemistry background, (2) hire student assistants to help with problem solving, and (3) include more of the needed mathematical background into the curriculum.

Ideally, one would also make MAT121 and MAT212 necessary prior knowledge for KJEM221, but this is unlikely to be doable within the current curriculum.

Finally, in terms of teaching premises, it would be wise to avoid Tripletten, and have the lectures in rooms where the slide canvas does not cover the blackboards.