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Advanced study techniques for university students *

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Abstract

The students starting at the Engineering Physics and Engineering Mathematics educations at Chalmers face challenges in terms of greatly increased workload and complexity of the subject matter compared to their previous education. Based on the experiences from teaching an introductory course in mechanics for nearly ten years (Ulf), the lack of efficient study techniques for a large number of students was identified. We have this year therefore offered the students a course in advanced study techniques (Daniel) tailored for university students, and also for their specific educations. We will here briefly describe the contents of the course and the preliminary impact on student learning.

Sammanfattning

Studenterna som börjar på utbildningarna inom Teknisk fysik och Teknisk matematik på Chalmers möter stora utmaningar i termer av kraftigt ökad arbetsbelastning och ämneskomplexitet jämfört med sina tidigare studier. Baserat på erfarenheterna från att ha undervisat en introduktionskurs i mekanik i nära tio år (Ulf) har vi märkt att en stor andel studenter saknar en effektiv studieteknik. Vi har därför i år erbjudit studenterna en kurs i avancerad studieteknik (Daniel) för universitetsstudenter och även anpassad till studenternas specifika utbildningar. Vi kommer här att kortfattat redovisa kursens innehåll och dess preliminära effekt på studenternas lärande.

Keywords: *Study techniques; student learning; student health; mechanics.*

1 Introduction

The students starting at the Engineering Physics and Engineering Mathematics educations at Chalmers are very high performing students, and have often been the best students in their respective classes before coming to Chalmers. However, their natural aptitude for learning, together with the much lower level of their previous studies, have in many cases enabled them to excel without a structured approach to learning or any specific study techniques; studying the night before a test, or not studying at all, has been enough. Until now that is. The fail rates for the first two courses (Introductory mathematical analysis and Linear algebra) were 52% and 43%, respectively, in the 2022/23 academic year. This means that a sizable group of students, who have basically never failed a test before, now failed **both** starting courses in mathematics, which are essential for their education and subsequent courses. This naturally leads to a lot of stress and less enthusiasm for the studies, affects the students' psychosocial health, and is one important cause of the high dropout rate of 30-50% for these educations. Furthermore, some of the students who now struggle and might drop out are the ones with the highest amount of natural talent, and

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hence no previous need for study techniques, who of course have the potential to become excellent engineers.

There are efforts made to teach study techniques at essentially all Swedish universities, but mostly in the form of self-studies and often more of tips and tricks than a thorough and comprehensive method. Chalmers is one example, where one lecture is supplemented with 20 short videos (Liljeqvist, 2019). Our impression is that these kinds of efforts have very limited impact, which is supported by the fact that the videos just mentioned has on average been viewed 117 times over two years despite that they are intended for all of Chalmers' students.

To address all the negative consequences mentioned above a collaboration with Daniel Benjaminsson was initiated, who through his company UnQap specializes in teaching advanced study techniques to a wide range of students and professionals, to create what we believe is the most ambitious course in study techniques at any Swedish university. Since Daniel is a former student at Engineering Physics at Chalmers he has a unique insight into the problems faced by the students, and he also knows the subject matter they are learning and can hence fine tune the study techniques accordingly. The workshop at KUL consisted of a theory part and then exercises allowing the participants to try the advanced learning techniques for themselves.

2 Advanced study techniques

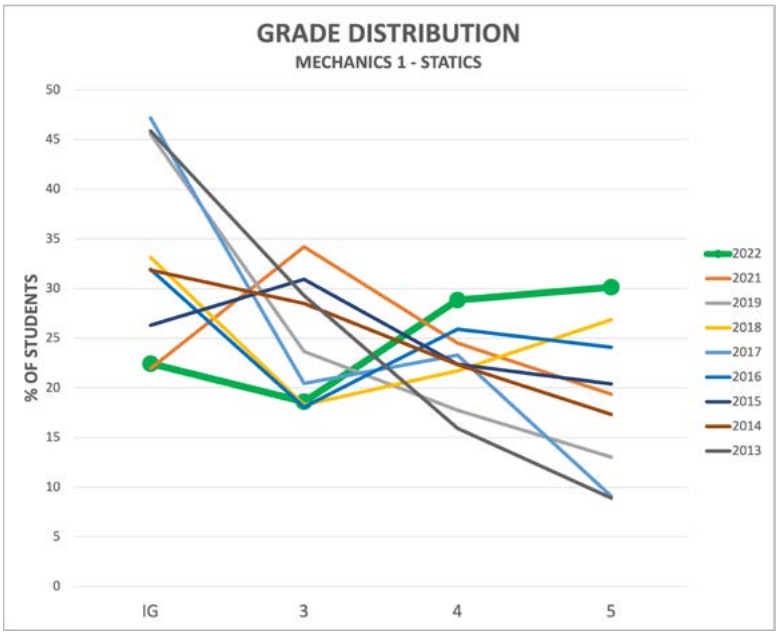
The introduced study techniques are in harmony with *constructive alignment* (Biggs, 2014), which is the preferred principle for course design and development at Chalmers. First, the learning outcomes of a course are analysed to identify what knowledge to focus most on, since time is limited and not all the contents in a course are of equal importance. Second, a large number of previous exams are briefly surveyed to make sure the identified focus areas are reflected by the exams, and also to sort the exam problems into specific learning outcomes for later study. Note that a student at this point do not know the subject, or how to solve the problems, but has a clear picture of what they are expected to learn and how the big concepts of a course are combined in exam questions.

The next task is to gather knowledge around the identified focus areas, which usually is achieved mainly through lectures, exercises and studying course literature. The tools and knowledge that the students gather throughout the course are then organized into a mind map (Buzan, 2006), which connects important concepts and problem solving techniques, thereby facilitating the students' *understanding* of the material. The last step is to memorize the mind map using the standard method of loci (Yates, 2011) combined with spaced repetition to convert to more long term memory (Mace, 1932). The study techniques were covered during a total of six lectures (2x45 min) before the exam reported below, and another five lectures in the following study period before the second exam.

3 Results

It is difficult to get hard evidence on the impact of this intervention, but there are some indications which together, we believe, paint a rather clear picture. First, due to ethical reasons, all students were allowed to participate so there is no control group. Approximately half the group, 70-80 students, did follow the course on study techniques. Exactly which students these were is not possible to determine since the course was open for all students. What we can do is to compare the grades for *all* students in the mechanics course between 2013 and 2022, the year of the intervention, excluding 2020 when there was an

Figure 1: Exam results before and after the intervention.



exam over Zoom due to Covid-19. The grades are presented in figure 1 and show a clear shift towards higher grades after the intervention, as well as a reduction of failed students as indicated by IG in the figure. In order to strengthen the argument that this is an effect of the intervention, and not due to the student group of 2022 being exceptionally strong, we also compare the grades for students in course Introductory mathematical analysis given in the study period before the mechanics course. The grades between 2011 and 2022 (excluding again 2020 due to Covid-19) are presented in figure 2, which shows that the student group of 2022 had both few high grades (4 and 5) and a high failure rate. It therefore seems unlikely that the strong results in the mechanics course was due to a stronger than usual student group. Further evidence for the efficacy of the study technique intervention is obtained if we compare the results for the re-exam for Introductory mathematical analysis given *after* the intervention, *cf.* figure 3. Note that the re-exam is given the year after the course started, so the 2023 re-exam is just after the mechanics course. Here we see that the student group which performed statistically well below average on the regular exam performed well above average on the re-exam. Since Daniel provided the students with tailored study technique material also for this course the intervention is a possible explanation for the improved performance at the re-exam compared to the regular exam.

Second, in the course evaluation the students were very positive, felt reduced stress and clearly supported continuing this intervention next year. A total of 73 students responded to the course evaluation and around 20 students spontaneously sent positive feedback via email. Below are a few examples, and a lot more can be found in the appendix.

- "The methods work fantastically well, the toolboxes [course specific mind maps] are also very nice to have since the first half of the year was a bit chaotic."
- "... They [the techniques] have made it easier for me to memorize many different things, and therefore I get less stressed that I'll forget a tool or concept during an exam. The learning techniques are also effective and save a lot of time."
- "I think the learning techniques have been very valuable, and I believe they will be helpful both in mechanics and in life in general."

Figure 2: Exam results in Introductory mathematical analysis.

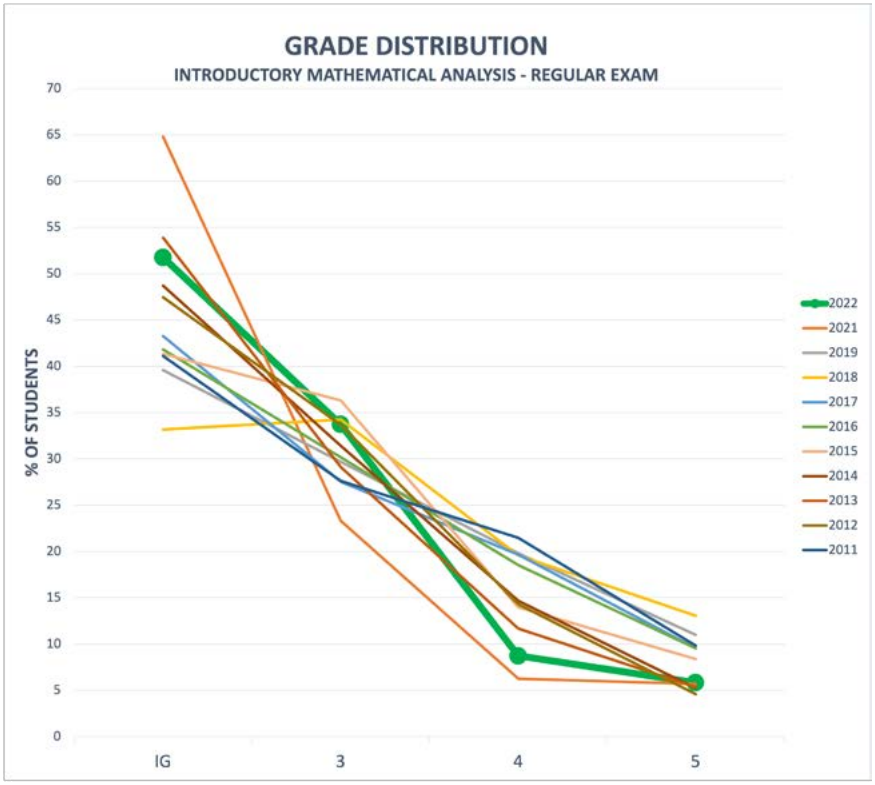
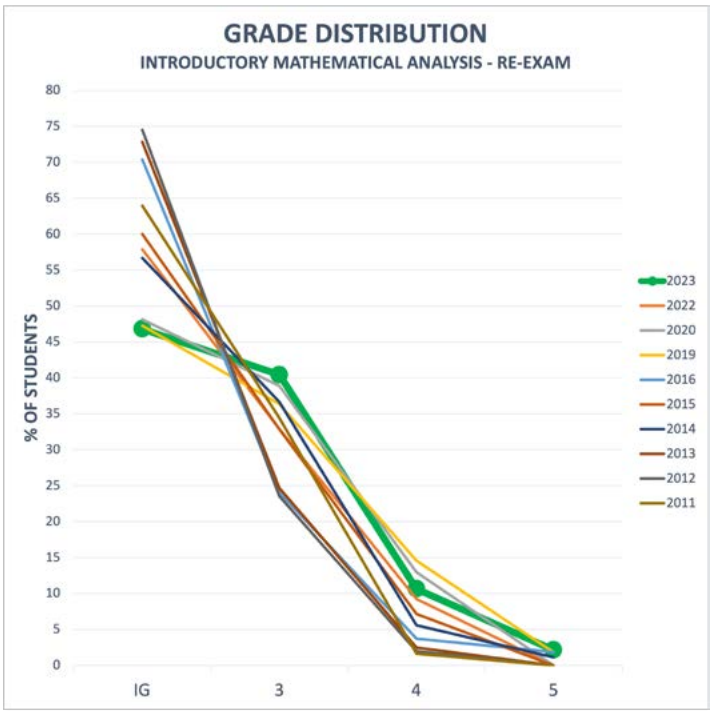


Figure 3: Results for the re-exam in Introductory mathematical analysis.



- "It feels like I have gained a better understanding now, and I feel confident about how to proceed with my future studies."
- "I failed the first two exams and quickly realized that I needed to change my study techniques. Then you [Daniel] came with your concept on a silver platter, and I decided to go all-in. The result [in the following exams] was a grade 4 in linear algebra, a 5 (full marks) in mechanics, and a grade 3 with a margin in the continuation course of mathematical analysis."
- "Very interesting content that has already helped me in my studies. It provides a comprehensive method."

Third, at the workshop two students gave testimonials where they shared how, after failing both exams in the first study period (before the introduction of advanced study techniques) the taught techniques enabled them to not only pass the courses in the second study period, but to obtain high grades. Furthermore, it also allowed them to easily pass the re-exam for some of the courses they failed during the first study period. Having followed up these students almost a year after the first study technique classes begun this positive effect has persisted through time, one of them even saying "The studies are incredibly easy now.". It should be stressed, however, that these students were not representative as averages for the student group, but should be viewed as a best-case scenario when fully committing to the techniques.

4 Discussion and Conclusions

Considering how effective this intervention seems to have been begs the questions why study techniques are not a natural part of what students learn at school. Spending just six lectures on learning effective study techniques can boost both student learning and psychosocial health, positively affecting the students' future life and career.

A Feedback from the students

Below are some additional feedback from the course evaluation questionnaire.

- "We have received genuinely helpful and concrete tips on how to improve our learning instead of just hearing that we need to study more/have a good sleep schedule."
- "First and foremost, I want to thank you [Daniel] for everything you have given and taught us during the study technique sessions. It means a lot!"
- "Extremely useful information described in great detail. We are also encouraged to test ourselves with the help of ready-made mind maps and examples. Moreover, we are encouraged to ask questions which motivates that you really want to learn and understand the techniques."
- "I feel that I now have a much clearer picture of how I should structure my studies."
- "It's simply an excellent deep dive into learning techniques. From the other people who previously came and spoke about study techniques, it has been hard to get much out of it as they only had one lecture. These have been very good."

- "... I also want to give feedback and say that it was really great that you made mind maps for us - it really helped to have a basis to start from. Especially in the continuation course [of mathematical analysis] when I had difficulty dividing things into categories, and I think I got a really good mind map in the end, largely because there was something to start from."
- "Thank you very much for both the mind maps and the feedback; it has really been helpful."
- "Thanks for an interesting course; it has been a great help!"
- "Very concrete examples and testing of application. Also helps with someone who "thinks" like a student and not like a professor."
- "An important subject that doesn't get enough focus in teaching."
- "Useful for any course, not just mechanics."
- "It's good to learn how to easily memorize; the mind maps created for the courses are very helpful!"
- "I think they [the lectures] are both interesting, fun, and it feels like you learn something useful. Good lecturer too. I also think you remember it well afterward. Good that you can easily ask questions, both in front of everyone and individually."
- "Very interactive with the students, and I like that we got to test making our own VIPS [memory exercises]. Above all, you always had the opportunity to ask questions, and it felt very relaxed."
- "Simply very good info, Daniel is awesome, and the study techniques and memory techniques are superb. Very good also to be able to email."
- "The setup was good and fun, everything was tied together well so it stuck [in memory] better. The subject was also good because it is interesting and useful."
- "You get drawn in very well, and you really got to see that it worked."
- "Good methods and committed teaching."
- "The toolboxes are very useful."
- "The lecturer's commitment was very entertaining, and the learning techniques are pretty powerful if you have the [memory] stories."
- "Interesting and useful methods and new perspectives."
- "Very educational and exciting."
- "Easy to understand the concepts. It seems helpful and works."
- "It's a good structure with interactive lectures. You get to learn fun and good stuff, so it feels very good and useful."
- "Good with information about the techniques, I've noticed that I don't have much technique. Especially mind maps, I've found, are good for increasing learning."

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