UNIVERSITY OF GOTHENBURG

DEPARTMENT OF MARINE SCIENCES

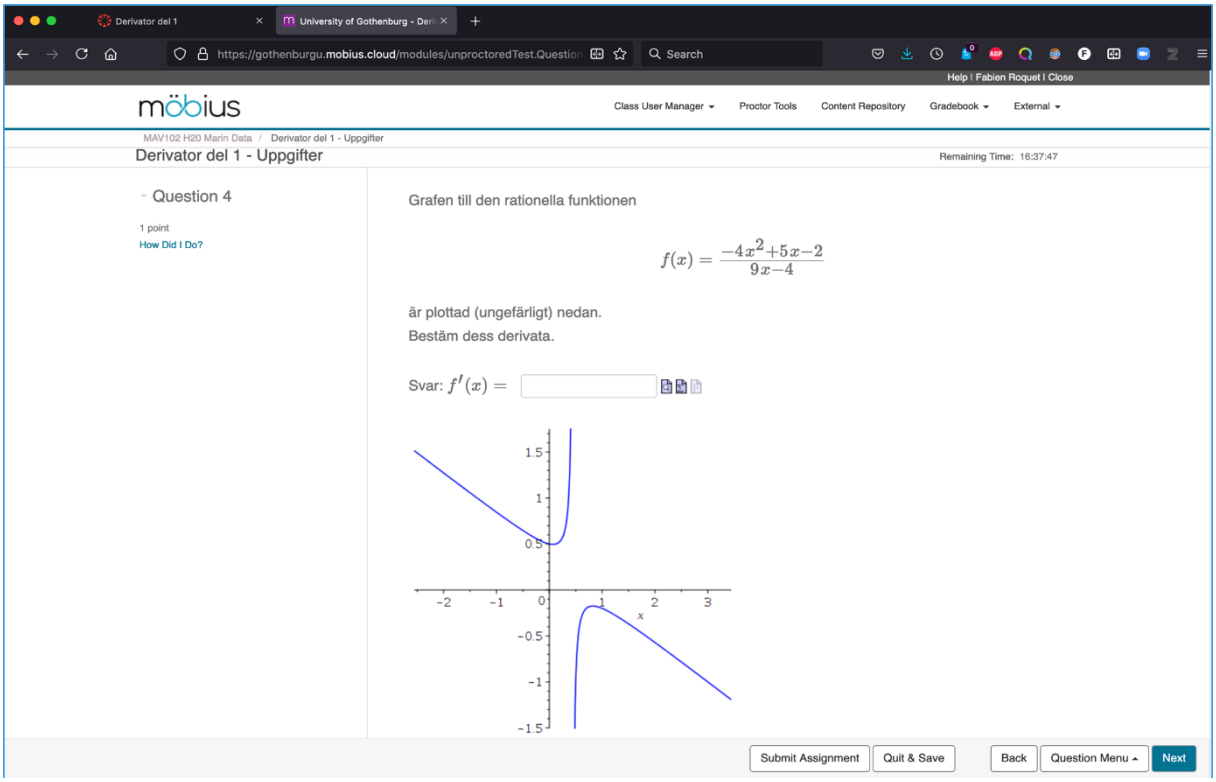

Figure 1: Randomly generated exercise given in the Möbius online platform.

DIGIKOMP PROJECT REPORT

Learning mathematics using an online courseware

Möbius for the Marine Science program

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Background

Since 2019, the department of Marine sciences has developed new, maths focused, online course material for the courses MAV101, MAV102 and MAV110. The online course material is made available through the web platform Möbius (DigitalEd). This work was done with the precious collaboration of Daminao Ognissanti of the Mathematical science department.

The original course material proposed in 2019-2020 was based on existing material that had been developed for the summer course Sommarmatte proposed to students at Chalmers during the summer just prior to the start of their Bachelor's studies with the addition of some more advanced material, in linear algebra and calculus.

Feedbacks from students revealed at the time that:

1. Students globally appreciated the flexibility offered by the Möbius courseware.
2. Students generally showed insufficient background in mathematics, and needed to be better trained during the course of the Bachelor in order to grasp the key concepts relevant to marine science.
3. But, the level of exercises taken from the Sommarmatte course appeared globally too high for a majority of students and therefore the course content offered in Möbius needed to be updated and tailored to fit the needs of Marine Science bachelor students.

The goal of the DigiKomp project "Learning mathematics for Marine sciences using an online courseware" that was funded in 2020 by PIL was therefore to build on that experience to improve the maths course material taught during the courses MAV101, MAV102 and MAV110, through the development of new video lectures and new automatically graded online assignments.

Scientific justification

Why is math so important? Math is the foundation for science, technology, and engineering (STEM). It is generally used in STEM to find patterns in data. These patterns can be used to test relationships, draw general conclusions about data, and model the real world. Despite its central importance, Math remains a difficult and often disliked topic for many students, including Bachelor students in our Marine

Science program. A significant fraction of students would even declare themselves afraid of Math. In order to put all our students on equal foot when they start our Bachelor program, it is important to give them the opportunity to refresh their basic Math knowledge and skills. However, standard Math class are not well adapted for this task, as some student will need to invest more time and effort than others to reach the minimum required level.

Hopefully the online courseware will improve the number of ways a student can learn mathematics. We seek in particular ways to teach Math concepts and tools for scientific fields such as Marine sciences, which rely heavily on Math yet do not require a deep understanding of the theoretical foundations of Math. We are very keen to share the course material and experience being gathered to develop further the use of this on-line platform at the University of Gothenburg. We feel this could be particularly valuable for students in chemistry, biology and Earth sciences.

Implementation

The PIL funding in 2020 has been used to hire Damiano Ognissanti from the Department of Marine Sciences during 6 weeks to:

1. reduce the overall difficulty of maths exercises,
2. propose exercises that are more readily applicable to marine science problems,
3. and create short videos and exercise tutorials presenting maths concepts at a level that best fit the needs of marine science students.

The work was supervised by the applicant Prof. Fabien Roquet. The department of Marine sciences agreed to make additional payments for overhead costs.

Three existing courses were selected for development: MAV101 *Den blå planetens historia* (given during the first part of the semester the first year), MAV102 *Introduktion till marin data science* (given during the second part of the semester the first year) and MAV110 *Marina modeller and databaser* (given during the second part of the semester of the second year).

The principal idea was to use online hand-ins with randomized elements to help students learn mathematics (see Fig. 1), since repeating material based on retaking

online quizzes with feedback (correct answer to previous hand-ins and hints) are effective as a learning method. The online platform Möbius is available for a reasonable pay-per-student fee (309:- /year /student), and can be seamlessly integrated in the web-based learning management system Canvas.

For each course item, a 5-10 minutes interactive video lecture (see Fig. 2) is provided to students. Students must then complete a series of 5-10 online exercises related to the same course content. MAV101 consists in 3 basic course items, MAV102 has 8 course items (covering functions and basic calculus) and MAV110 has 6 course items (calculus and linear algebra).

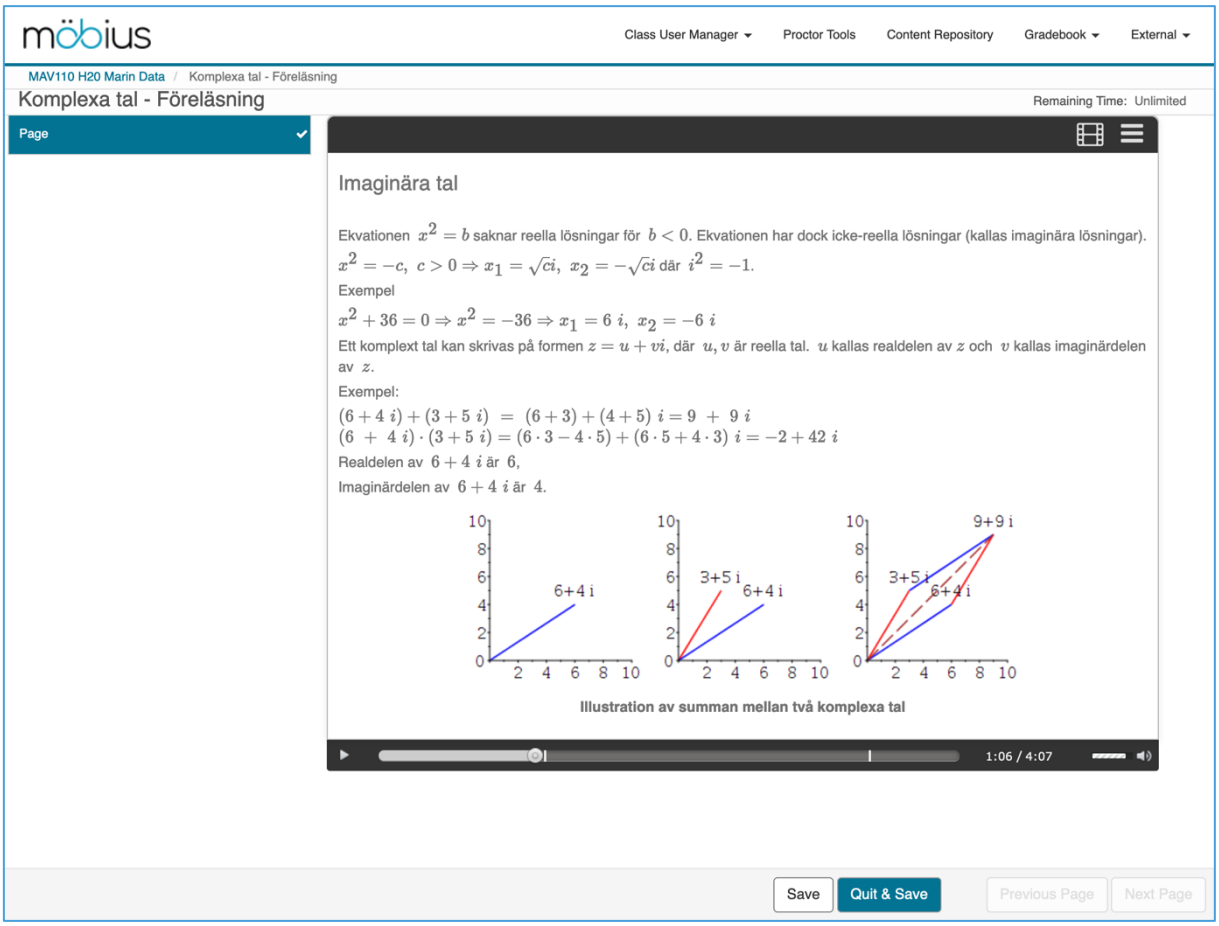

Figure 2: Caption of a video lecture on Complex Numbers on the Möbius online platform.

Results

The DigiKomp funding has been very useful to achieve all the envisioned goals and as a result, the Department of Marine Sciences is now able to offer an online resource well adapted to teach Math to the Bachelor student of our Marine Science program.

Two attempts at assessing what students thought about the online courseware content are now reported.

The first feedbacks were obtained at the end of the course MAV101 in the form of an anonymous quiz. Ognissanti (2021) provides a detailed analysis of the answers, combined with a statistical analysis of student results. Here we repeat the concluding section of this report:

This project examines the use of digital material to help students repeat mathematics theory on an undergraduate level. It is found that the students actually redo hand-ins they have passed, and that, for this group, repeating rules of arithmetic operations is something that is more easily done than learning more abstract material (which is reasonable since they view mathematics as a tool to be used to solve their problems in Marine science rather than a subject to be studied all by itself). The results are relatively consistent in most cases, for each specific part of the course and for all tools analysed. The results retrieved by all the students were not expected to be statistically significant, but they could be considered as some evidence of improvement of this group's knowledge in basic mathematics.

Short interviews of four voluntary students were also carried out at the end of MAV102. Here we report answers related to the hands-in (duggorna) which arguably corresponds to the key element of the online courseware content.

Hjälpte duggorna i Möbius dig att lära dig matematik?

- Duggorna var bra, för att du måste klara dem för att klara kursen. Det är drivkraften bakom studierna. Jag arbetade så att jag först tittade på duggan och använder sedan videor, föreläsningsanteckningar och Google för att klara duggan.
- De hjälpte mig definitivt, klarade man duggan på första försöket kunde man teorin väl och kunde gå vidare, men behövde man göra om så behövde man repetera och läsa på. Det hade varit trevligt med uppgifter att provköra innan man gjorde duggan, för det fanns nog för få uppgifter i kursen.
- Det var bra repetition. Jag hade en formelsamling när det kom till viss ny teori, som till exempel en lista över kända primitiva funktioner. Jag kunde även använda

Wolfram Alpha för att kontrollräkna mina svar när det behövdes, hade nog behövt fler ”How did I do”- försök[1]. Man kunde även använda Wolfram för att hitta lösningssteg för uppgifter som saknade ett räkneexempel i Möbius, vilket var tacksamt.

- Duggorna var bra för att man fick friska upp minnet, dels när man repeterade teori, men även när man skulle knyta ihop säcken med ny teori. Var teorin ny kunde det hända att man fick Googla lite.

Lessons learned

Students appreciate the possibility to learn at their own pace, and are very negatively affected by external stresses such as time limits or exams.

Students are used to find information on the net, and dislike when this possibility is removed. Most are in particular aware of the existence of websites such as Wolfram Alpha to solve simple mathematical problems.

Many students like to work in group, and see their studies as an opportunity to socialize as much as a path toward a future job.

Students are aware of the importance of Math, but most do not wish to become expert as they consider computers and the internet can assist in solving their problems whenever needed.

The use of an online courseware platform to teach Math has proved invaluable during the distant teaching period generated by anti-Covid restrictions.

Literature

Damiano Ognissanti (2021). Teaching Mathematics with digital tools at the department of Marine Science at the University of Gothenburg. Report on a pedagogical project for the Department of Mathematical Sciences, Chalmers University of Technology and the University of Gothenburg.

[1] “How did I do”: For each exercise, students get the opportunity to test once whether they answer is correct or not before they submit. This possibility was found very valuable, as it relieves some of the stress students may experience while doing their exercises and allows them to avoid small typos and correct themselves when they are really close to the right answer.