

Introducing an interactive digital exercise book

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Abstract—The course *Water resources and Hydraulics* is given to students in their second year of the Civil engineering programme at Chalmers University of Technology. In spring 2021 an interactive digital exercise book (Yata) was used in the course. Yata is defined as a digital training environment for exercises and assignments within STEM. The aim was to assess whether implementation of Yata supported interaction between students, promoted reflection and illustrated progression of the student learning in a course taught online. The students' experience of using the material was evaluated in the middle of the course and in the final course survey at the end of the course. Student and teacher interaction was evaluated in Yata. Students' learning was evaluated through the final written exam. Yata provided a tool for teacher-student questions but it had a limited effect on interaction between students. To some extent Yata promoted student reflection with the feature Hints. Yata was much appreciated by students by its feature to illustrate student progression. Yata provided valuable feedback on student progression to the teaching team through the function Analytics.

Index Terms— Digital exercises book, STEM, Yata

I. INTRODUCTION

INTERACTIVE textbooks have become more available to students and teachers in recent years. These textbooks have the advantage of including features such as animations of concepts or other interactive media. In their study, Asrowi et al [1] demonstrated increased student learning among students in a class of a junior high school in social science while using an interactive e-book. In the STEM-field, Edgcomb et al [2] compared student learning using static textbooks to interactive textbooks. In their study, they demonstrated that students were supported by interactive textbooks.

The aim of this paper is to assess whether implementation of an interactive digital exercise book supported interaction between students, promoted reflection and illustrated progression of the student learning in a course taught online.

II. METHOD

A. Background and course layout

The course *Water resources and Hydraulics* is given to students in their second year of the Civil engineering programme at the Chalmers University of Technology. Approximately 200-220 students follow the course each year.

The course layout is based on lectures, consultations, laborations and seminars. The course was transformed and given remotely online in spring 2020 due to the COVID-19 pandemic. At that time, the collection of problem-solving exercises was a printed compendium where solutions for several exercises were available. What emerged in the course evaluation in 2020 was that the students worked alone solving the exercises and that many students felt isolated when not being able to interact with students or teachers on the course topic. The teachers noted that very few students visited the online occasions where the students could ask questions and get help from the teachers. In spring 2021, the course was given remotely online again, with similar layout as in 2020, with the difference that the exercise book was now an interactive digital exercise book (Yata).

B. Interactive digital exercise book

In spring 2021 the interactive digital exercise book (Yata) was for the first time used in the course. Yata is a software that is under development and it is defined as a digital training environment for exercises and assignments within STEM [3]. The following services of the Yata software used in the course were: *Analytics*, *Question* (including the feature *Hints*) and *Posts*.

Analytics. Through an analysis function, the teacher could follow the student group's progression, but not the progression of individual students.

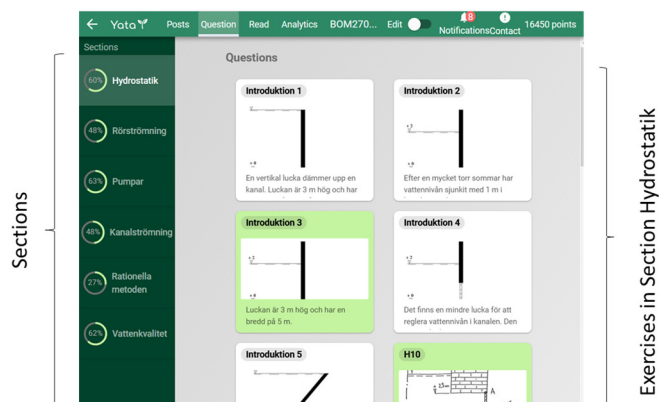


Fig. 1 The top green bar shows the tabs Posts, Question and Analytics used in the course. The teacher determines how to divide the course material into sections. In each section, the teacher adds the exercises. When the student has solved the exercise, the exercise is highlighted in green and the student can visually see their progression in the Section (e.g. 60% completed for Hydrostatik) and the number of points in the right corner.

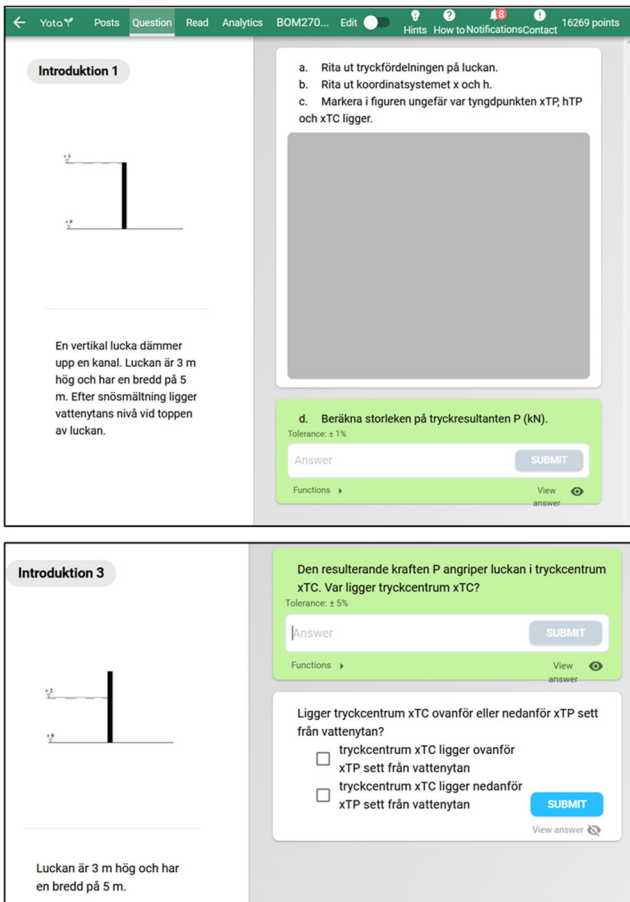


Fig. 2 Example of layout of the exercises. There are several different options to ask a question. In Introduction 1a-c, the grey box is a self-check. The student solves the exercise, press the grey area and is then presented with the correct answer. In Introduction 1d and Introduction 2 the student fills in a value. In Introduction 2 at the bottom, the student chooses an answer (quiz).

Question. In Yata, the teacher creates several sections, Fig. 1. In each section, the teacher enters the exercises to be solved. There are several options regarding how to pose the questions and which answer to ask for, Fig. 2. For the exercises for which an answer is requested, a tolerance span is specified. The student clicks on each exercise and solves it. The student submits the answer and receives back either 'correct answer' or an indication on how far from the correct answer the student is, e.g. 'about 90% of correct answer'. When the student has solved the exercise, the exercise is highlighted in green and the student can visually see their progression, Fig. 1.

Hints. When the student has solved an exercise, a box called *Hints* appears, Fig. 3. Here the student is asked to reflect on the exercise and briefly write down the steps they went through to solve the exercise. The purpose of *Hints* is to let the student reflect on how the student has solved the task. The student can then share with the student group how the exercise can be solved (*Give a hint*). The idea is that for each exercise more and more hints are created as students work with the exercises. A student who has difficulties solving an exercise can take help from a *Hint*. *Hints* are directly linked to the exercise being solved and students can upvote a hint if it helped them, thus

promoting better hints.

Posts. Posts is a discussion forum where students and teachers can communicate, Fig. 1. Students can pose questions and students can answer each other's questions as well as search for answers to questions. Teachers can also answer questions asked by students or post information. The answers from teachers are marked with a 'T'.

C. Qualitative measures for evaluation

The students' experience of using the material was evaluated in the middle of the course (midterm course survey 45 answers) and in the final course survey at the end of the course. The final student survey was answered by 42 out of 216 students. Student and teacher interaction was evaluated through the *Analytics* function in YATA. Students' learning was evaluated through the results of the final written examination of the course.

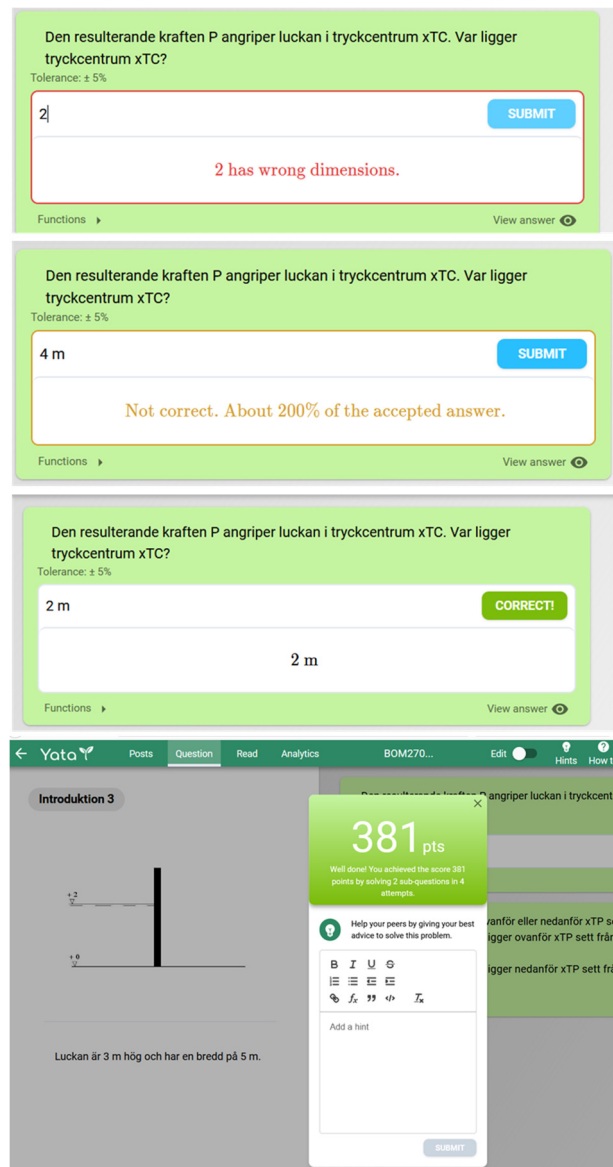


Fig. 3 An example of a student solving Introduction 3 in Fig. 1. The software checks the unit of the answer. Thereafter, if not correct, it indicates how far of the answer is from the correct answer. Once the answer is correct, the student receives points for completion and is asked to add a hint.

III. RESULTS AND DISCUSSION

How many students used Yata? The students chose if they wanted to use Yata or buy the compendium second hand. At the end of the course a total of 166 students had started solving exercises on section 1 in Yata, and this number decreased thereafter for each section. In the final course survey, the students were asked if they used Yata, the printed compendium of the exercise book, a combination of compendium and Yata or something else. Out of total 42 respondents, 21 students answered that they used Yata, while 14 students answered that they used a combination of YATA and the printed compendium. One student in the final student survey reported that several students solved the exercises together in a group, but only one student filled in their answer in Yata. Consequently, the numbers in the *Analytics* function give an indication on how many students have started using Yata, but the exact numbers should be used with caution.

When did the students solve exercises? The *Analytics* function in Yata indicated that students did not get started on solving exercises when the course started. The *Analytics* function showed that after the first week, 105 students had started solving exercises in section 1 in the course material, and 49 had started solving exercises in section 2. To keep up with the progression of the course, the students were expected to have started section 2 after the first study week. From the course survey we have an indication that part of the student group used a combination of the printed compendium and Yata or worked in groups solving the exercises, thus it could be more than 105 students that had started solving exercises. Students are guided in the course syllabus when to start working with the different sections and exercises. The *Analytics* function in Yata indicated that not all students start solving exercises in accordance with the course syllabus. In the course survey, some students provide the explanation that they wait with solving exercises until they have a grasp of the course content. Some students say that they failed to solve the exercises and could not continue as there were no ready-made solutions in Yata they could follow. The analysis function provides feedback to the teaching team that the course structure may need to be changed next year to further stimulate the students to start solving exercises early in the course. Deslauriers et al [4] also stress the importance of explaining to students why changes in a course are made and how it will support student learning. In the future, we will explain more clearly to students how to use the media and how it supports their learning.

Hints or ready-made solutions? In the mid-course survey and through communication between students and teachers, it became evident that at least part of the student group is used to learn the course material by studying ready-made solutions of exercises. In Yata no ready-made solutions to the exercises are provided, and the students should instead get hints through the feature *Hints*. In the printed compendium ready-made solutions to some of the exercises were provided. This is one of the reasons that students used both the compendium and Yata. The *Hints* came up gradually throughout the course, and this unfortunately unintentionally incentivized students to be a little behind in the course so that more hints would appear. Halfway

through the course teachers identified this as a problem. To circumvent it, the teaching team added hints for the recommended exercises to encourage students to follow the pace of the course. The drawback of teacher-added hints was that students now lacked the motivation to add hints themselves. One aspect when implementing Yata was to increase reflection for the students. 32 students in the course survey say that they used a hint left by teacher or student. Clark et al [5] argues that students on a beginner level benefits of clear guidance to support their learning, thus, where teachers fully explain concepts. Once the basic understanding has manifested, more elaboration on exercises can be addressed. It may be that the set-up in Yata should have provided more teacher support on basic exercises and that hints should rather be used for the more complex exercises.

Did using Yata motivate students? One student says that it was good to have an online exercise software, as the student uses a tablet device and a digital pen, which made it easy to copy/paste figures while solving the exercises. Some students report in the course survey that they liked using Yata since it was perceived as well structured and one could see their progress. 29 students in the course survey reported that it was motivating to see that the exercise is marked green once they have solved it. Also, it was appreciated to see the percentage of completion of the section. This was used by the students to decide when to move on to the next section. There were mixed answers on whether the number of points awarded for each solved exercise stimulated and motivated students or not.

Did using Yata promote interaction? The purpose of *Posts* is that a student can turn to both students and teachers and ask a question. As a student, you can also search among posts to see if anyone else has already asked the same question. The teaching team noticed that communication through posts mainly took place through student – teacher interaction. Students appreciated that they could ask their question anonymously. In the course survey, it is indicated that it was less useful to have answers to questions in *Posts* because these were not linked to the exercises. Students would have preferred that the questions were directly linked to each exercise. This has now been addressed and changed in Yata. Students reported that they appreciated that they could search for answers to questions in hints and posts whenever they wanted. Thus, students were not limited to teacher assigned times to find the answer to a question. For teachers it was easy to manage *Posts* and to answer them when all questions were gathered in the same place. One challenge with *Posts* for teachers was that it created a request from students to respond fast to new questions. Scheduled times when teachers answered *Posts* had to be communicated to the students. Another challenge with both *Hints* and *Posts* was that often parts of the solution were graphical which could not be conveyed in a good way through the software, as it only enabled text answers or equations. Thus, all had to be communicated by text, this added further complexity to student-student or student-teacher interaction. This has now been addressed and figures can now be uploaded in *Posts* in Yata.

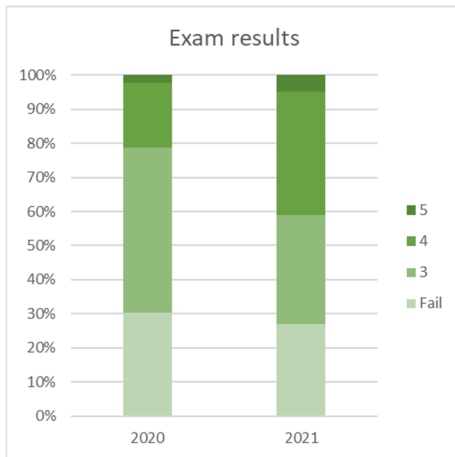


Fig. 4 Exam results 2020-2021. Grades ranges from Fail, 3 ,4 and 5 where 5 is the highest grade.

Did Yata support student learning? Comparing exam results from previous years does not provide conclusive arguments on the effect of using Yata. In 2020 and 2021 the exam was restructured, held online and all material was available for the students. Although the layout of the exam was similar between the two years 2020 and 2021, the two student groups had very different experience of online examination. Students in 2020 had just experienced one online exam before, while the students in 2021 have studied online for a little more than a year, Fig. 4.

IV. CONCLUSION

Yata supported teacher-student interaction but it had a limited effect on promoting interaction between students. To some extent Yata promoted student reflection with the feature *Hints*. Yata was much appreciated by students by its feature to illustrate student progression. Yata provided valuable feedback on student progression to the teaching team through the function *Analytics*.

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