SET$^{\text{TM}}$: Self-Evaluation Tool supporting both students and teachers

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Abstract —**In this paper, we share experiences from a pedagogical project which aims to improve mathematics teaching for engineering students. Solving problems is central to mathematics studies and the project is about identifying the tasks that students need more support and developing methods of providing customized support. To achieve the goal, we develop our own digital tool SET$^{\text{TM}}$ and implement it in Canvas. The effect of the project is measured as a continuous feedback from students' work. Students are encouraged to use digital the tool for self-evaluating their work with recommended data, which then provides statistics on students' progress in working with the tasks. Teachers use the information to adapt the teaching.**

Keywords—**mathematics education for engineering students, digital tools, differentiated instruction**

I. INTRODUCTION

THE transition from high school mathematics to university mathematics that many students encounter is long discussed problem internationally. The step from being a student to becoming a student means, among other things, having more responsibility for the studies. This in turn requires that students need to plan their studies and not least to have overview of their study situation. Large student groups with less teacher contact, and a change of learning habits and study organization have an important impact on student performance. An important part of the students' studies is the self-study: many of the beginner students find it very difficult to study on their own and to find the right study technique. The design of the learning process, the quality of teaching and teaching styles differ from those in urging a need for students to become autonomous learners. The teaching at university is more impersonal resulting in students feeling lack of support from instructors when experiencing difficulties. Moreover, research shows that the secondary-tertiary transition is more difficult in mathematics-related subjects and that dropout rates are significantly higher than in other subjects.

II. ONGOING PROJECT

The goal of the present project is to find methods to follow first-year students' development in order to overcome the transition problems in mathematics courses. A new self-evaluation tool, that we are going to describe in detail in the subsection "Description of SET$^{\text{TM}}$ ", was introduced and we used the information to formally change the teaching process. During the project we followed the implementation of these changes and how the learning process was influenced.

The project was implemented in several mathematics courses for Engineering Programmes during 2019-2021. A pilot study was conducted in the spring semester 2021 in one of the courses for the Scientific Base year and we are going to present some results below.

Because of the Covid-19 pandemic, many courses changed form from campus to online teaching. Our experience shows that the digital tool SET$^{\text{TM}}$ for self-evaluation is a valuable tool in both types of teaching. Also recently, SET$^{\text{TM}}$ has been tested in other subjects with good results.

III. DESCRIPTION OF SET$^{\text{TM}}$

During the project, the students were offered the possibility and were encouraged to use the website which contains a special constructed digital tool SET$^{\text{TM}}$ (Self-evaluation tool). SET$^{\text{TM}}$ is a part of https://www.sola.kau.se which is WordPress's multisite for Karlstad University.

The tool contains matrices (displayed in Fig. 1) that store all recommended tasks for every lecture in the course. We constructed this tool with the purpose to give both students and teachers a better picture of the students' progress in the work with exercises. The effect of the project is measured over time as continuous feedback from the students' learning. According this principle, we have two different views: the student's view and the teacher's view.

The first implementation of the tool was done in the form of an Excel document which was filled in by the lecturer with a list of all elements in the course with associated exercises. The next implementation was done in WordPress with support from the university pedagogical unit. The students gain access to the SET$^{\text{TM}}$ through Canvas. They fill in the template with self-evaluation of how own work with exercises went, based on a four-point scale:

- "Not Done" if the student has not worked on the assignment
- "Need Help" marks the tasks that the student had worked on but need help with
- "Some Concern" marks the tasks that the student solved after getting some help
- "Confident" marks the tasks that the student successfully solved by himself

As the student mark the assignments, color also changes in a row for the assignment (as shown in Fig. 1):

- "Not Done" unchanged
- "Need Help" turns red
- "Some Concern" turns yellow
- "Confident" turns green
- the blank boxes turn gray

Fig. 1. Matrix filled by a student

At the same time the students fill in their matrices, they can see how the summary of the lecture changes in a both table and chart (see Fig. 2). The student has access to both forms in real time.

Fig. 2. Compilation of results of a part of the course for an individual student in tabular form

Each student gets a clear picture of own progression, that is how much remains to be done, which steps are the most difficult and easiest, respectively. When preparing for the exam, the matrix can be used by the student to get an idea of which elements of the course he or she must pay special attention to. The use of the tool for organization of and control over own studies turned out to be one important result in this project.

The self-evaluations can be anonymous, if prefered. There is an option to choose in the teachers report.

Our software written in WordPress analyzed the collected information in real time and shows it at seminar-group level and whole group level. These summary is shared with all teachers in the course. An example of such summary is displayed in Fig. 3 and Fig. 4.

At every seminar the teachers used the group statistics to formatively adapt the teaching. Teachers can also use the statistics discover the students in need of challenge.
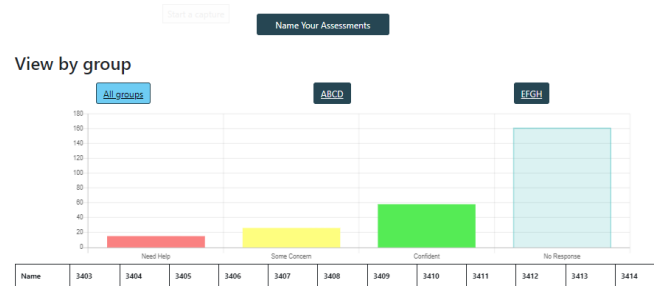

Fig.3. The teacher's view: students' rapport at seminar-group level and whole group level. In chart form.

Fig. 4. The teacher's view: students' rapport at seminar-group level and whole group level. In table form.

IV. SOME RESULTS FROM A PILOT STUDY

A pilot study was conducted in the spring 2021 in one of the courses for the Scientific Base year. First results from the pilot (where 38 students answered an annonymous questionnaire) indicate that students appreciate the self-evaluating system as a useful tool in their studies for structuring own studies, for getting information about the level of their difficulties in the course and getting better help from the teachers.
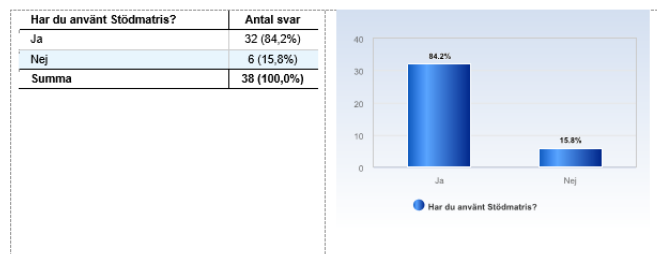

Fig. 5. Students using (84,2%) / not using (15,8%) SET^{TM}
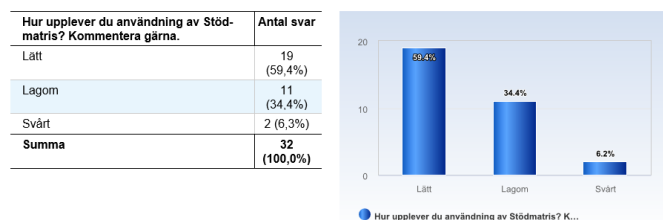

Fig. 6. Students finding SET^{TM} easy (59,4%)/ intermediate (34,4%)/ difficult (6,3%) to use

Upplever du att dina frågor togs upp av din lärare på grund av din redovisning av Stödmatris?

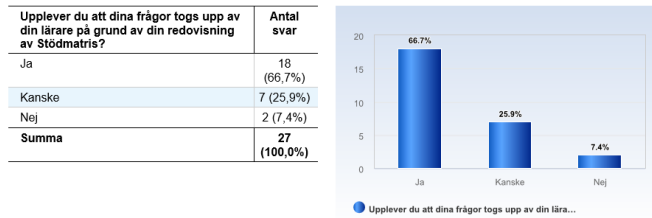| Upplever du att dina frågor togs upp av din lärare på grund av din redovisning av Stödmatris?	Antal svar
Ja	18 (66,7%)
Kanske	7 (25,9%)
Nej	2 (7,4%)
Summa	27 (100,0%)

Fig. 7. Students that feel that their questions have been answered (66,7%)/ partially answered (25,9%)/ not answered (7,4%) by the teacher based on their use of SET^{TM}

För vilka ändamål har du använt Stödmatris? Du kan välja flera alternativ.

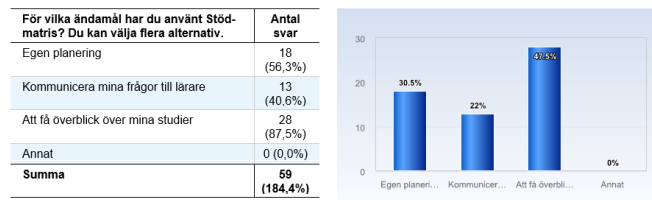| För vilka ändamål har du använt Stöd-matris? Du kan välja flera alternativ.	Antal svar
Egen planering	18 (56,3%)
Kommunicera mina frågor till lärare	13 (40,6%)
Att få överblick över mina studier	28 (87,5%)
Annat	0 (0,0%)
Summa	59 (184,4%)

Fig. 8. Students that used SET^{TM} for own organization/ to communicate their difficulties with the teacher/ to get a picture over own study pace (multiple answers allowed)

Skulle du vilja använda verktyget i framtiden?

Skulle du vilja använda verktyget i framtiden?	Antal svar
Ja	27 (71,1%)
Nej	3 (7,9%)
Vet ej	8 (21,1%)
Summa	38 (100,0%)
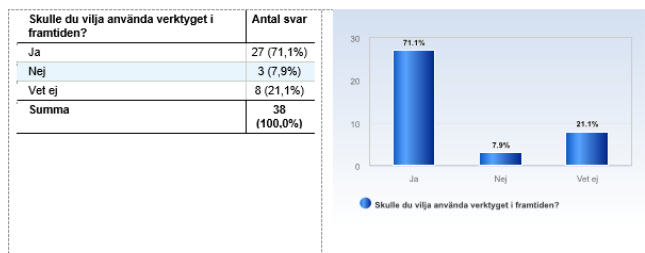
Kommentar

Jag tycker det har varit kanon med stödmatriserna! Jag förstår inte varför man inte använder den. Så enkelt att gå tillbaka och repetera och planera sitt arbete!

Fig. 9. Number of students willing (71,1%)/ not willing (7,9%)/ unsure (21,1%) to use SET^{TM} in future courses

V. SUGGESTED PRINCIPLES FOR COURSE PLANNING

The following principles are partly tested in the project, partly results of our reflections during the project. We suggest the following principles when planning a mathematics course for engineering students:

❖ Incorporate the self-evaluation tool in the course' homepage on the local learning management system.

❖ From the students' perspective the self-evaluation tool needs to contain the possibility to easily

- reach the list of recommended tasks in the course
- report the status of their work.

The continuous reports work as a practical tool for students' own organization and control over the status of their studies.

❖ From the teachers' perspective the digital tool needs to capture and organize the continuous feedback to support the planning and preparation of the teaching.

- The teachers get continuous updated statistics that they use to decide which tasks should be discussed in detail.

- The students having difficulties are encouraged to share their report with the teachers enabling more support.

- The students having good self-evaluations are encouraged to share their reports in order to get new challenging tasks.

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