# Development of Simple Public Assessment Sheet and its Use in Elementary Physics Laboratory Course

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## INTRODUCTION

Physics studies in engineering education curriculum has traditionally included some laboratory work, either on its own laboratory course or integrated within a theory course. The advantages of the laboratory work are often seen to be deeper understanding of the concepts, development of the measurement-based engineering problem-solving and analysing skills and technical reporting skills [1]. Years ago student feedback in Tampere University of Applied Sciences indicated that the amount of ECTS credits compared to amount of work done is lower in laboratory

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courses than in theory courses. On the other hand, student feedback also indicated that students have learned a lot of important skills during their introductory physics laboratory course. In Tampere UAS the physics education and introductory physics laboratory education is under continuous development. One of the recent main focuses on laboratory course development has been the assessment of the laboratory reports. The paper reports the development of the public assessment sheet for laboratory reports and its usage. Small survey of student experience concerning the usage is also reported.

## 1 LABORATORY WORK AND ASSESSMENT

Even though learning outcomes of the laboratory work is seen important, the laboratory courses encounter some challenges. The laboratory education is often more expensive than traditional lecture education because studying needs more time, guidance and more expensive facilities. The student experiences on the laboratory course are contradictory. Research results show that laboratory experiences of the students are reported negative or dull, mainly because the tasks, working and the solution methodology are pre-stated [2]. On the other hand, student feedback from Tampere UAS and an Australian study [3] shows that physics laboratory work provides students with many important skills that they think they do need in the future. According to Blathal [3], laboratory working is also seen to be useful, understandable, interesting and enjoyable by the students. To enhance students' learning outcomes and to reduce the dull effect of too much pre-stated aspects, the introductory laboratory course in Tampere UAS has included students' self-designed and implemented laboratory work, which is reported as a poster [4]. Traditionally laboratory work means real hands on working with real equipment in real laboratory. Modern ICT gives more flexible possibilities to different kind of laboratory implementations. Nowadays laboratories can be simulated or remote, meaning that the physical laboratory equipment is remotely used via network [5].

The assessment of the laboratory work may vary among implementations. The assessment is often assessment of the communication of the results on a variety of different possible methods from informal discussions to formal laboratory papers [1]. The challenges rising from this type of assessment are the coherence of the assessment among teachers responsible for assessment. The most common reported tool to tackle the challenge is the use of the public assessment rubric (ordered list of descriptions indicating different levels of performance) [6] [7]. The assessment rubrics can be used either in only one direction, from teacher to student, or in two-way setup, in which students self-assess their report using the same assessment rubric before teacher's assessment [8].

## 2 DEVELOPMENT OF LABORATORY REPORT ASSESSMENT

Before the development, the laboratory course assessment in Tampere UAS was based on the learning objectives of the laboratory course but there were no detailed assessment criteria publicly available for the students. Laboratory course feedback indicated that the basis of the assessment was not clear to students and there were clear differences between different teachers' assessments. In teacher's point of view, the quality of the students' reports also needed some improvement. There were reports of significantly high quality by motivated students, but some of students' reports were poor in quality. The first step to enhance the assessment of the students' laboratory reports was to create common, detailed and public assessment

criteria, which is easy to use and understandable for the students. The form of the assessment criteria was decided to be a table that fits on one single landscape A4 sheet of paper. In the table, simple, but detailed enough descriptions of the typical performances on different grades on different sections of the report are described shortly. The sections of the report assessed are structure, theory, description of methods and apparatus, calculating results, error estimations, presentation of final results and conclusions. As an example the descriptions of two highest grades 4 and 5 of the theory-part of laboratory report, is found in *Table 1*.

*Table 1.* Example descriptions

| 4 | 5 |
|---|---|
| …<br><br>**Theory**<br>• Comprehensive<br>• Only some shortages regarding to implementation<br>• Not a direct citation<br>• Some references marked, list available in the end<br><br>… | …<br><br>**Theory**<br>• Comprehensive, structured, fluent text<br>• Clearly connected to the work<br>• Implies that the author understands what is written<br>• Consistent referring according to instructions<br>… |

Teachers use the assessment sheet by circling the relevant description according to the student's performance on particular section of the report. The final grade of the report is based on the average of the grades of the different parts of the report, all seen on the same assessment sheet. Using the assessment sheet gives student a profile of the report, how he has managed in different parts of the report, where he has succeeded and which parts need some improvement in the future. Some written comments are also included in the students' reports.

In 2015 the two-way use of the assessment sheet was piloted in three different student groups. The assessment sheet is included as appendix in the students' reports. The reports are submitted digitally. Before submitting the report to the teacher, students are asked to make self-assessment using the same assessment sheet as the teacher uses, by circling or highlighting his self-assessment to the sheet. Students are also asked to indicate their personal goal for the final grade of the report. Teacher's emphasis is usually to push their students to outdo themselves, and give the report back to be corrected even though it could be acceptable. This could lead to frustration of both the student and the teacher. For the teacher, students do not push as hard as wanted and for the students, they feel that their efforts are "never" good enough. In order to reduce the possible frustration, it helps if the goal of the student is clearly marked and the teacher recognizes the student's goal and tries not to push the student further.

## 3 SURVEY AND RESULTS

A survey concerning the assessment sheet and its use was implemented in the two-way-use pilot groups. 52 of the 90 students answered the survey. The survey included questions concerning the assessment, the assessment criteria, the use of the assessment sheet and the self-assessment.

Students were asked to evaluate given statements concerning the assessment sheet using 5-point Likert scale from 1 – totally disagree to 5 – totally agree. Distributions of the answers are presented in *Fig.1. – 8.*

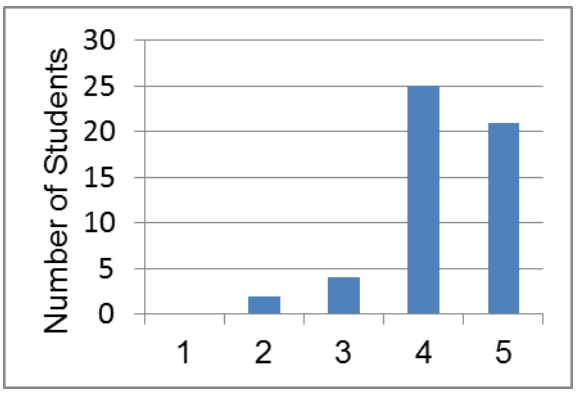


*Fig. 1.* "I know how the grade is formed"

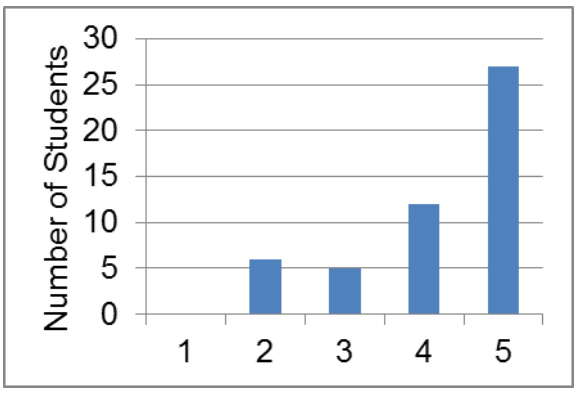


*Fig. 2.* "The assessment sheet is easy to understand"

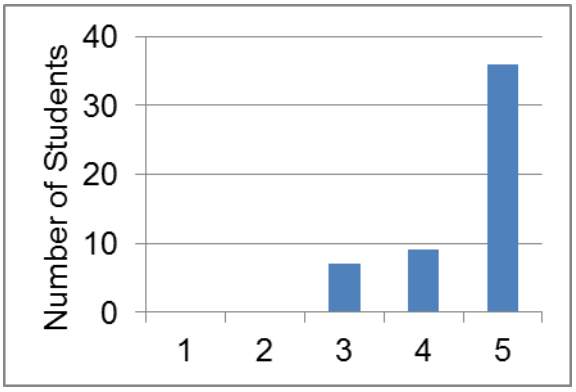


*Fig. 3.* "The assessment criteria must be public"

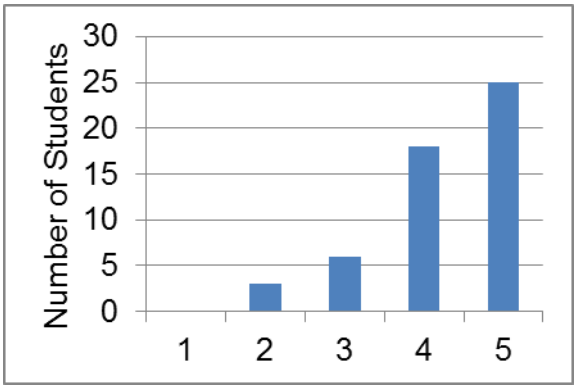


*Fig. 4.* "The assessment is done according to the criteria"

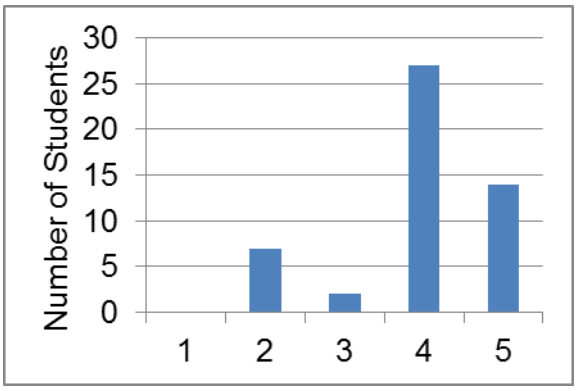


*Fig. 5.* "The assessment of my reports is fair"

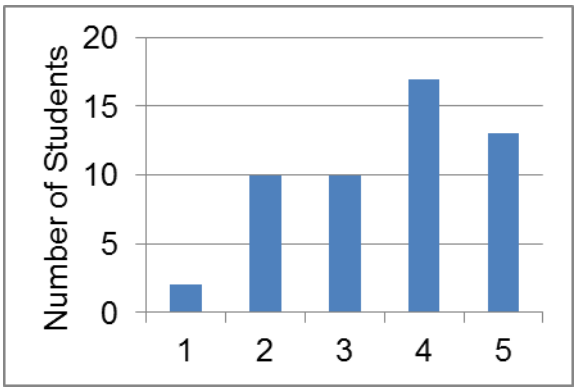


*Fig. 6.* "In addition to the assessment sheet I also need more precise feedback"

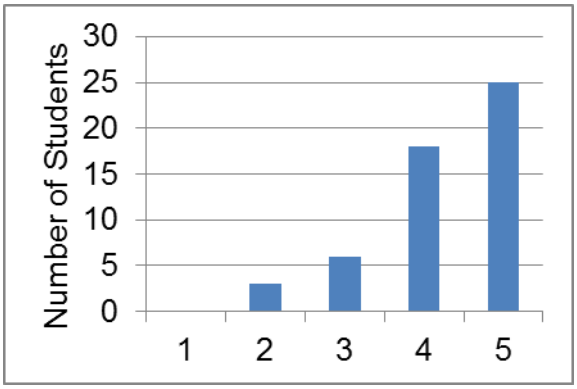


*Fig. 7.* "I make better reports when I know the assessment criteria"

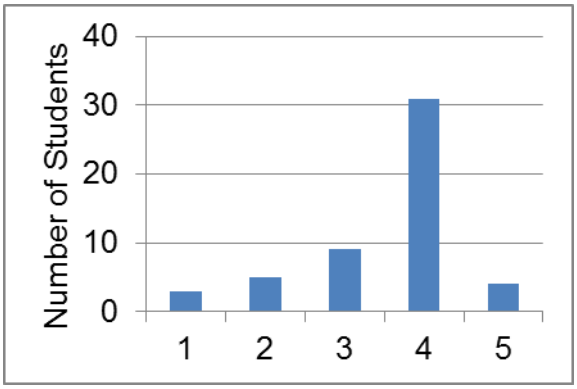


*Fig. 8.* "I am able to anticipate the grade of my report"

Results presented in *Fig. 1.* and *Fig. 2.* show that students are familiar with the assessment criteria of the laboratory course, and for the majority of students the assessment sheet is understandable. The results in *Fig. 3.* reveal that students strongly agree that the assessment criteria must be public. According to the results presented in *Fig. 4.* and *Fig. 5.*, a great majority of students agree that the assessment is fair and done according to the criteria, but there still are a few students that partially disagree the fairness of the assessment. The written comments in the survey points to the fact that student's experience is, that in spite of common criteria teachers still assess reports differently.

The assessment always directs students' performance. One goal for public assessment criteria was to enhance students' learning outcomes. Results presented in *Fig. 6. – 8.* indicate, that the assessment sheet is insufficient as the only feedback method but helps students improve on with their reports. Majority of students are able to anticipate the grades of their reports.

The use of the assessment sheet as students' self-assessment tool helping students to improve their performance, was surveyed using multiple-choice questions of how students use the possibilities of self-assessment. The results are presented in *Fig. 9. – Fig. 12.*

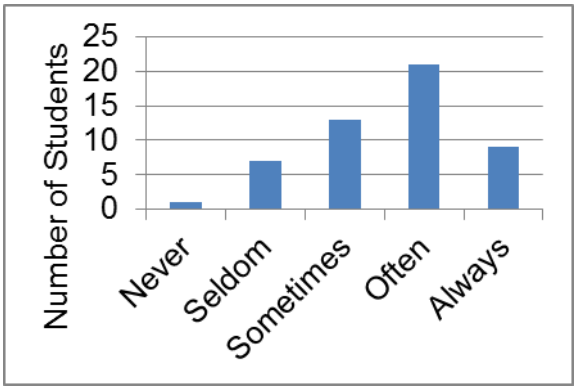


*Fig. 9.* "I set a goal to my grade"

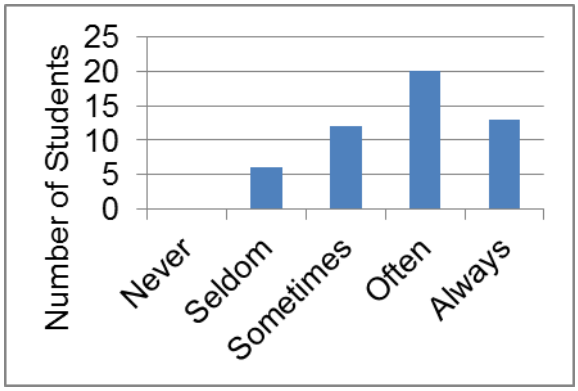


*Fig. 10.* "I make a self-assessment"

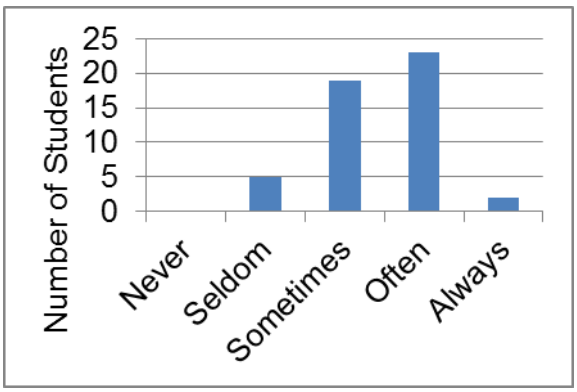


*Fig. 11.* " In self-assessment I recognize the deficiencies in my report"

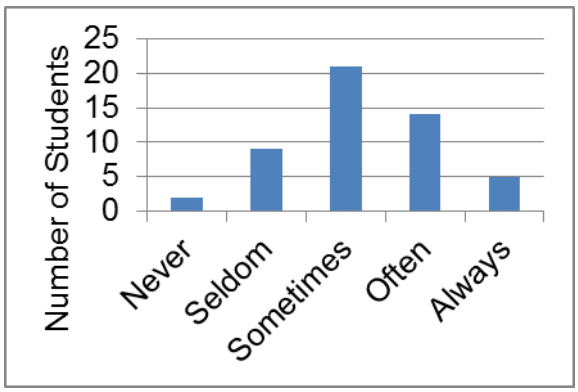


*Fig. 12.* "I improve my report after the first self-assessment"

The results presented in *Fig. 9.* and *Fig. 10.* indicate that majority of students set goals to their grades and use the assessment sheet for self-assessment before submitting the report to the teacher. According to the data presented in *Fig. 11.* and *Fig. 12.* the assessment sheet helps students to recognize the deficiencies in their reports but improving the quality of the report does not happen that often.

According to course feedback and discussions with laboratory teachers, the feedback only rarely collects negative statements concerning the assessment. It can be said that the public criteria and the use of the assessment sheet have been good decisions. According to the discussions with teachers the quality of the reports is still diverse. The public criteria and their active use do not automatically push students to enhance their efforts.

## 4 CONCLUSIONS

As the conclusions of the study it can be said that the public assessment criteria has helped students to understand the basis and the goals of the assessment of their reports. The use of criteria has also reduced the amount of students' misunderstandings connected to the quality of their reports. This kind of assessment criteria could also have a negative impact concerning the quality of the reports. If the student aims only to the lowest possible grade that the report is not failed, the public criteria helps on that. This may lead to the optimization of the used time and effort.

Overall the criteria and the assessment sheet is widely appreciated by the students and according to the study, helps them improve their performance in reporting. The sheet helps students at the first stage, the recognition of the initial stage, but it is still up to the student's personal goals and motivation to improve the performance.

In the future, the details of the assessment sheet will require some improvements in order to make the descriptions even more descriptive. It could also be interesting to use similar assessment sheets also in other engineering laboratory courses.

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