Improving students' writing skills through effective small-group peer feedback

Final Report

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Contents

1. Introduction

The Eindhoven University of Technology (TU/e) is currently pursuing efforts to innovate the existing study programs both at bachelor and master level. One of the major consequences is the growth of students in all departments. At the Electrical Engineering (EE) department the growth in number of students has gone from 69 in 2010, to 76 in 2011, to 77 in 2012, to 103 in 2013, and finally to 166 in 2014[1].

Furthermore, in a recent study conducted among a number of teachers at the EE[2] department it was identified that writing skills are an important academic ability that still needs considerable attention. In addition, within the framework of the Graduate School master redesign, a needs assessment survey[3] has been carried among all EE research groups. One of the major problems mentioned by the research group members were the low quality of writing skills both at technical and at academic level.

Moreover, TU/e vision 2030[4] advocates for a personal contact and the master-apprenticeship model. The EE department is keen on looking for suitable educational methods that can bring about potential solutions for the development of academic writing skills. Furthermore, to optimize feedback and relief the teachers' burden and supervisor's, potential options to explore are peer feedback and peer assessment or feedback in small-groups, feedback techniques in the form of peers, feedback during the group presentations or colloquia within the research group, and online methods to support students' outside the TU/e during the external internship. The overall goal of this study is to find out suitable solutions upon which to build a sound educational strategy to be extended to and adopted in other courses.

1.1 Context of the project

The EE educational department has developed a strategy to face the growth in the number of students, and more specifically, to support students to still be able to acquire the proper writing skills. The educational strategy that we proposed to confront the number of students is based on small-group peer feedback. The rationale for this approach was also led by the assumption that, due to the large number of students, the teachers and supervisors are not able to pay individual attention to students' personal needs and/or that the feedback will take place in a minor scale or not at all. Moreover, as feedback is regarded in research studies as powerful educational

[1] Instroom eerstejaarinstelling Bachelor per 1 oktober.
[2] EE Internal short overview of teachers' observations on writing skills. (2014)
[3] EE Internal report on Master Redesign (2014).
[4] Meijers, A. & Brok, P. den (2013). Ingenieurs voor de toekomst: even essay over het onderwijs aan de TU/e in 2030. Eindhoven: TU/e https://www.tue.nl/uploads/media/TUe_Onderwijsvisie2013.pdf

'weapon' the EE educational department wanted to build our educational strategy upon this principle. Feedback has been researched in order to identify the most suitable method to apply and learn how to provide effective feedback, but also feed-up and feed-forward to guarantee that students' writing skills are at the level of the end qualifications of a Bachelor engineer and a master graduate.

1.2 Scope of the project: objectives

The project included the following objectives:

- To develop an educational strategy to provide effective small-group peer feedback that can be used within the department in BEP projects but also in other courses at bachelor and master level;
- To improve students' writing skills through effective peer feedback;
- To create an IT online platform for the students to provide feedback during external internships.

As the Bachelor End Projects (BEP) are one of the major concerns, the project started focusing on a first pilot with a BEP project Smart Sustainable Society (quartile 3 & 4, 2014/2015); in a second pilot master students of Random signals and processes and Computational physics participated (quartile 1, 2015/16). The results of these pilots are presented in section 3 (3.3) and 4 (4.3) respectively.

1.3 Scope of the project: expected outcomes

The expected outcomes of the project as expected are stated below:

1. N= 18 to 20 BEP Smart Sustainable Society students have been trained in peer feedback and peer assessment methods;
2. Teachers/supervisors have learned and used coaching methods to provide feedback;
3. An educational and effective strategy grounded on peer feedback that can be easily adopted in other EE bachelor and master courses;
4. Training materials and feedback instruments are developed to be used in all kinds of courses and settings;
5. The quality of students' reports has been improved.

1.4 Project phases

In table 1 provides an overview of the project phases.

Table 1. Overview of project phases

Project management and phases	Time line
Initial phase	
Literature review	January, 2015
Desk research	
- Rapid appraisal of existing peer review approaches and selection of approaches	
Development of peer feedback & training materials	February, 2015
- Training development for BEP students	
- Training for teachers on feedback techniques setup of criteria, etc.	
Project implementation (1st. Pilot)	March, 2015
- Coaching sessions with students	
Evaluation of results	July, 2015
- Development research instruments and questionnaires for interviews	
- Revision of reports	
- Interviews with BEP teachers and students	
- Adjustments in project & peer feedback approaches	
Project implementation (2nd Pilot)	September, 2015
- Test peer feedback tools in other master courses	
- Evaluation of results	November, 2015
Dissemination	October, 2015
- Project presentation in 3TU annual conference	
- Journal paper	November, 2015
Final project report	December, 2015
- Report writing: final report for 3TU management	

In the coming sections, we summarize the scope, phases and outcomes of this project. In section 2 we present the desk research. Next, the overview of the organization and structure of the pilots and the results are presented (section 3 details the first pilot; section 4 the second). Finally, we summarize the conclusions and the lessons learned.

2. Desk research

2.1 Method

The desk research consisted of a quick appraisal of literature on (peer) assessment and (peer) feedback. We used seminal works, our dissertations (Gomez Puente, 2014; Thurlings, 2012), and previous innovation projects in which we were involved. Results of the desk research are presented in section 2.2. Additionally, we consulted literature and course materials of courses we have followed ourselves that focused on academic writing. Based on these results, the first pilot training was developed, also in consultation with dr. ir. Guus Pemen, who is responsible for the BEP projects in the track Smart Sustainable Society of EE.

2.2 Findings

Feedback is considered as "information provided by an agent regarding aspects of one's performance or understanding" (Hattie & Timperley, 2007, p. 81). We used the model of Hattie and Timperley in combination with findings from Thurlings (2012) to operationalize effective feedback that is feedback that supports learning. Such effective feedback focuses on the task and process (Hattie & Timperley, 2007) and is therefore focused on the goal (Thurlings, 2012), rather than being focused on the self (Hattie & Timperley, 2007) or person (Thurlings, 2012), which is considered ineffective. To support answering the questions *Where am I going*, *How am I going* and *Where to next* (Hattie & Timperley, 2007), feedback should be clear, specific, detailed, and neutral rather than too positive (only compliments) or too negative (overly critical, harsh; Thurlings, 2012).

Second, we used the findings from an advice to the Bachelor College (Thurlings, de Jong, & Beijaard, 2015). This advice centered around the question: how can peer review be implemented at TU/e such that it supports student learning and which factors influence this? Peer review or peer assessment was defined as "an arrangement in which individuals consider the amount, level, value, worth, quality, or success of the products or outcomes of learning of peers of similar status" (Topping, 1998, p. 250). Findings showed that training of peer review skills, building experience in peer reviewing, combining peer review with self and/or tutor review, and clear criteria are essential for effective peer review.

Additionally, a number of practical issues were revealed. Thurlings et al. (2015) formulated specific tips for lecturers that express lessons learned, such as the importance of clear criteria for peer feedback and training of peer feedback. These tips were taken into account when developing the training sessions and materials: For example, during the kick-off meeting, guidelines for providing effective feedback (Hattie & Timperley, 2007; Thurlings, 2012) were

presented. As such students were trained and could build experience by discussing good and bad examples and peer reviewing each other's work. Because students were supervised by lecturers and because we also give feedback to their BEP reports, tutor feedback was incorporated. By providing criteria for assessing their peer's work and providing a part of the rubric (column excellent), students became familiar with the criteria for their BEP reports. Finally, by phasing the project in a small pilot and scaling up to the master phase, while taking into account all lessons learned (based on Thurlings et al., 2015 and the pilot) we followed Purchase (2000), Sivan (2000), and Topping (1998; see also Thurlings et al., 2015).

3. Pilot 1

3.1 Overview

Based on the literature review on peer feedback and on training and in consultation with Pemen, we designed the training course focusing on five pillars:

1. Peer feedback among students;
2. Trainers' feedback on BEP papers;
3. Expert's feedback (i.e. teachers & supervisors) on BEP papers, both on content and on writing skills;
4. Academic writing following scientific information on writing papers;
5. IEEE guidelines[5].

The setup of the training consisted of one short introduction meeting and three content-focused sessions. The program contained topics reflecting the expected outcomes of students regarding IEEE papers, such as the introduction, abstract and title, along with results and methodology section, and discussion and conclusions. These were specified in the form of criteria lists for the peer review, and final assessment rubric for both the students as well as the supervisors. Subsequently, the set-up of each meeting is presented.

The first meeting was a kick-off, in which the aims and trajectory of the training were explained. Furthermore, during the kick-off we focused on developing an outline for the BEP reports. This outline mainly describes the sections or headings of the report and, if possible, a short description of the text under the (sub) sections or (sub) headings. After this first meeting, students were provided with 'homework', which was to create the outline of their BEP report.

[5] IEEE guidelines stem from IEEE journals. These journals form the core of EE publications, and therefore students are obliged to use these guidelines when writing their BEP paper.

The second meeting began with peer feedback: students were placed in dyads in which they provided each other with feedback on their outline. To support this process, we created a list of criteria for assessing the outlines. The remaining of the second meeting was devoted to writing the introduction section. The elements of introduction sections were addressed and we used good and bad examples of introduction sections of BEP reports from previous years that were provided by Pemen. After this first meeting, students were provided with 'homework', which was to write their introduction section.

The third meeting began, similar to the second, with peer feedback. Now, feedback was provided within the same dyads on the introduction. To support this process, we created a list of criteria for assessing introduction sections. The remaining of the third meeting was focused on the method and the results sections. Elements of both sections were addressed, such as using tables and graphs for displaying results. Furthermore, the examples provided by Pemen were used again to explore method and results sections from real-life BEP reports. After this third meeting, again students were given 'homework', which was to write their method and results sections.

The fourth and final meeting also began with peer feedback. In their dyad, students gave each other feedback on the method and results sections by means of the list of criteria that we developed. The remaining of this meeting was devoted to writing the conclusion and discussion sections, the title and abstract, and IEEE guidelines. IEEE guidelines are used within the department Smart Sustainable Society for BEP reports. Additionally, good and bad examples of previous BEP reports were used. Students were provided with a list of criteria for assessing the conclusion and discussion sections, the title and abstract, and IEEE guidelines. Finally, we provided students with the opportunity to hand in their BEP reports and we gave them feedback based on the assessment rubric we developed (see appendix 4) and the IEEE guidelines.

In addition to these four meetings, an instruction meeting for the supervisors was organized monitor the BEP track Smart Sustainable Society projects of the students. During this meeting, the trainers presented the BEP training approach regarding the IEEE papers, the content presented during these sessions, the criteria lists and the assessment rubrics. It is worth mentioning that some of the supervisors have been involved in the design of this assessment rubric.

3.2 Method

3.2.1. Development of self-assessment instruments: before and after measurements

In order to measure the impact of the training on the expected improvement of writing skills we developed a questionnaire based on a Likert scale of 1 (totally disagree) to 7 (totally agree) to measure the starting level of the students (see appendix 1). The same questionnaire was used after the training to measure the students' gains in writing skills according to own perceptions.

We analyzed students' gains by comparing the 'before' and 'after' situation to know whether there are significant differences in writing skills. Results are presented in section 3.3.1.

In addition, we also asked students to send an example of a report written by them in previous years or quartiles. The aim was to analyze the start level of writing skills based on a real example. Furthermore, based on this analysis of writing skills, the trainers provided feedback against the expected end level and according to IEEE guidelines and criteria.

3.2.2. Development of supervisors' perceptions of students' writing skills

In addition to the students' self-assessment of their writing skills, a supervisors' assessment form (appendix 2) was developed along the same kind of questions regarding the IEEE paper. The same Likert scale of 1 (totally disagree) to 7 (totally agree) was applied. Two open-ended items were added, asking for the supervisors' opinion of students' strengths and weaknesses in writing and for their expectations of the training.

3.2.3. Development of assessment and peer review tools, e.g. rubrics and criteria lists

We developed a rubric to assess students' writing skills, which we applied to participants' most recent writing product prior to the training and to their BEP report after the training. This rubric was developed based on the criteria of IEEE guidelines (see Appendix 3) and in consultation with four EE-lecturers. More specifically, we made a first version of this rubric which was then discussed with the four lecturers. Based on their comments and suggestions, the rubric was adapted. This second version was used during the pilot.

Additionally, based on the assessment rubric, the criteria lists were developed separate for each section of a BEP paper (i.e., outline; introduction; methods and results; conclusion and discussion; title and abstract; IEEE guidelines; see appendices 5, 6, 7, 8, and 9). These criteria lists

were provided to the students over the course of the training sessions in order to support peer feedback.

3.2.4 Development of training evaluation forms

We developed a questionnaire that was used to evaluate the training sessions from the students' point of view (see appendix 10). On a 7-point Likert scale, we collected students' opinions on, for instance, their satisfaction with the four training sessions and the peer feedback. Results are presented in section 3.3.4.

In addition, we interviewed four lecturers who supervised students who had participated in the training. For example, we asked to what extent they had noticed their students' participation in the training and to what extent students' writing skills had improved. Results are presented in sections 3.3.2 and 3.3.3. The criteria to select the supervisors were based on:

- Previous experience in supervising BEP students at the EE department;
- Students that they supervised have followed the training on writing skills;
- Supervisors have attended the instruction meeting on how to coach and assess students' writing skills.

3.3 Results

3.3.1 Student writing skills

The results of the students' level in writing skills were measured in two different moments: start and end level. The sample consisted of 11 students who took part in this research study. Ten of completed the pre-test, and nine of them also completed the post-test; for eight students the pre- and post-questionnaire were complete. In table 2, we provide an overview of the means per item of the questionnaire for these 8 students. Comparing the students' means, we observed higher means in all items after the training has taken place. This indicates that the training has had an impact on students' writing skills according to their own perceptions.

Table 2. Comparison of students' scores based on self-assessment

	Before		**After**	
	Mean	**SD**	**Mean**	**SD**
All items	3.76	1.01	5.07	0.86
item 1	3.63	1.18	5.38	0.74
item 2	3.62	1.40	4.88	1.25
item 3	4.00	1.41	5.50	0.93
item 4	3.75	1.16	5.75	0.71
item 5	3.57	1.51	5.00	1.15
item 6	3.50	1.20	4.38	1.30
item 7	4.38	0.92	4.88	1.13
item 8	4.38	1.30	5.00	0.76
item 9	3.63	1.30	5.25	1.04
item 10	3.75	1.01	5.07	0.86

In addition, we also conducted a t-test taking into consideration the students' start and end level self-assessment scores on writing skills as shown in Table 3 to know whether the training has had some impact on their writing skills. As observed in the means, there are gains in students' writing skills according to students' perceptions on all items in the questionnaire. First, the overall mean score of all items was significant ($t=-4.057$, $p = 0.007$). Additionally, there were significant differences regarding the following items: 'I know how to write a short and concise title for an IEEE paper/technical paper'; 'I can write an abstract succinctly and straight to the point'; 'I know what I have to write in the introduction section of an IEEE paper'; 'I know what the characteristics are of a good introduction'; 'I know how to organize and give structure to an IEE paper/BEP report'; 'I know what I have to write in a discussion and conclusion section of a IEEE paper and/or technical reports'; and 'I know how to describe research findings and results in an (IEEE) paper including proper use of verbs, choosing the right words, sentences and paragraphs'. We can conclude therefore that the training has had a positive impact on students' writing skills according to their perceptions.

Table 3. Results of paired t-test on students' self-assessment of writing

Item	t-value	p-value
1. I know how to write a short and concise title for an IEEE paper/ technical paper	-3.862	0.006*
2. I can write an abstract succinctly and straight the point	-2.376	0.049*
3. I know what I have to write in the introduction section of an IEEE paper	-3.969	0.005*
4. I know what the characteristics are of a good introduction	-6.110	0.000*
5. I know how to organize and give structure to an IEEE paper/BEP report	-2.500	0.047*
6. I can write a coherent methodology section providing overview of methods, techniques and data	-1.369	0.213
7. My (IEEE) papers illustrate scientific evidence with appropriate data that support/reject hypotheses	-1.000	0.351
8. I know how to present findings that are coherently linked to the results	-1.488	0.180
9. I know what I have to write in a discussion and conclusion section of a IEEE paper and/or technical reports	-3.052	0.019*
10. I know how to describe research findings and results in an (IEEE) paper including proper use of verbs, choosing the right words, sentences and paragraphs	-4.583	0.003*
Average of all items	-4.057	0.007*

*= significant at 0.05

3.3.2 Summary of supervisors' perceptions

The general findings of the supervisors interviewed are:

- Improvement has occurred mainly in the representation of results in the graphs, tables and figures. These are clear and well documented.
- References are used properly;
- No major changes in structure and quality of reporting throughout the paper.
- Some supervisors mentioned that the section 'Introduction' has improved as this includes now more insights on the contexts, problem to be addressed, and the relevance of the problem to the community.

There are still some elements which still need some improvement:

- The introduction and formulation of the problem, in stepping out of technical problems and looking further for interconnections, jumping into conclusions. Logical order of presenting results and ideas;
- Summary of conclusions in this section needs to include more arguments based on the results.

3.3.3 Detailed summary of the interviews with the supervisors

One supervisor coached one student who participated in the training; he was the second supervisor and did not talk with the student about the training. The supervisor has corrected about 12 BEP reports of students in the automotive track and saw that, in contrast to previous years, all building blocks of an article were included in these reports. This might be because of the training, which was explicitly focused on these building blocks. The supervisor strongly recommended applying this in the second pilot as well. On the other hand, BEP reports are still too descriptive, but that has to do with the BEP project as a whole: it goes beyond a regular lab report but not as far as a scientific article. Therefore, this supervisor believes the rubric's standards were too high for BEP students. He has given the rubric to some master students he is supervising, because the rubric does provide the standard for master theses. For future BEP training, he suggested to keep the rubric simple: problem statement, the research itself, and future research suggestions. For future training, he also suggested exploring online assessment/feedback, because that could be more efficient.

Another supervisor mentioned that there have not been major changes in the quality of the different sections of the paper (e.g. abstract, introduction, method, etc.). The amount of time to guide them is also the same. However, where there have been an improvement is the way of presenting and illustrating results with the graphs, tables, and figures.

The third supervisor was neutral about the quality of the reports. Where the training has certainly helped is in stimulating students to start writing on time.

The assessment rubric has been used but only by the teachers/supervisors who were involved in the development of the rubric and in giving feedback to this assessment tool.

3.3.4 Results of the evaluation of the training

The training was evaluated by 9 students based on the following aspects (see appendix 10):

- content of the three different training sessions;
- level of satisfaction and quality of feedback regarding peer feedback, trainers' feedback, experts'/supervisors' feedback;
- general perceptions about good/less good issues and/or aspects that were missed and can be improved.

Regarding the training, only 9 students completed the evaluation form. Results show that the students were positive about the training sessions and about how much they can apply what they have learned (see Table 4).

Table 4. Students' opinions on training course

	Questions	Mean	SD
1	I can apply what I have learned to improve my writing skills	5,2	1,2
2	The assignments requested too much time and effort in comparison to the quality of (peer) feedback I received on my assignments	3,7	1,9
3	The examples, slides, hand-outs and theory used were sufficient and appropriate	5,6	1,1
4	The number of lecture sessions was sufficient	5,8	0,9

In addition, students are satisfied with the peer review approach (see Table 5), the feedback provided by the trainers (Table 6) and the teachers/supervisors' feedback (Table 7).

Table 5. Students' opinions on peer feedback

	Questions	Mean	SD
1	Peer feedback you receive from your colleagues/students was good	5,3	1,3
2	The peer feedback I received from my colleagues helped me to improve my writing skills	5,2	1,0

Table 6. Students' opinions on trainers' feedback

	Questions	Mean	SD
1	Trainers'/Lecturers' feedback you receive was good	5,5	1,0
2	Trainers'/Lecturers' feedback I received helped me to improve my writing skills	5,5	0,9

Table 7. Students' opinions on teachers' feedback

	Questions	Mean	SD
1	Teachers' feedback you receive was good	5,3	1,3
2	Teachers' feedback I received helped me to improve my writing skills	5,3	1,3

Recommendations for further improvement were made on:

- giving complete examples;
- a study guide, containing general information about the course and some resource materials;
- reduce the number of training sessions from 4 to 3; or two long sessions.

3.4 Conclusions and lessons learned

The training has been positive towards improving students' writing skills regarding the following aspects:

- Make students be aware of IEEE paper guidelines;
- Provide structure to write an academic and technical paper;
- Learn how to become critical towards each other's work;
- Start writing on time.

However, the training has not been completely improved students' writing skills in all aspects of the IEEE outcomes as expected by the teachers.

4. Pilot 2

4.1 Overview

The results of the first pilot were discussed with the Director of Studies of EE and the colleagues of the EE educational institute. It was agreed that in order to enhance students' writing skills in the master it will be important to further develop a strategy focusing on the following:

- Integrate the approach of the first pilot into the second pilot by using the same setup for peer feedback and content-focused training;
- Integrate writing skills within master core courses using the material and the content of the courses (i.e. Computational physics and Random signals and processes). In this regard, we assure that this professional skill is anchored to the expected level of the course on the one hand. On the other, we try to build a complexity line of development along different courses that is expected at the end of the master;
- Develop analytical and critical thinking skills through writing as a first step towards enhancing the expected writing skills and thinking level for the master thesis.
- Link with the Graduate School (GS) 'Skills Lab' and encourage students to use this platform as a learning tool

In addition, in relation to the growth in number of students, we wanted to experiment with IT tools and get the possibility to experience with in it order to learn whether IT works to support students. Following the blended-learning developments at other TU/e departments with PEACH for peer assessment and peer review, the EE educational department held some meetings with experts on PEACH (i.e. Erik Scheffers) at the Math department in order to:

- learn from these experiences and avoid mistakes;
- ask for support to develop an IT PEACH platform for 2 master courses;
- get trained in the use of PEACH.

In this regard, we had some concerns to run this pilot for all students, and we decided to select (voluntary) only a limited number of students for the application of PEACH as peer feedback tool. However, due to small number of students participating in this course (only 12 students) we finally involved all students in this study. We basically want to learn about the functionality of this tool and then further apply it in other courses later on.

The selection of the master courses was made based on the type of assignments which are embedded in the content of these courses. Writing and organizing a report on the weekly assignments and the need to structure the calculations and findings in the form of analysis, interpretations, adjustments iteratively, and making sound conclusions were fundamental

criteria issues to select the core master courses Fundamental Random signals and processes and Computational physics.

Furthermore, grounded on the positive results of the first pilot (i.e. peer feedback, feedback by teachers and trainers, self-assessment and the development of assessment instruments) has had on students' writing skills, we focused on whether the peer feedback was useful to support students to gain and development writing skills and whether they believe they became more critical towards the way they revise their work. In addition, we also assessed students' satisfaction regarding peer feedback they received from other students, the feedback given by the teachers and the feedback provided by the trainers/instructors. Finally, we also evaluated the training module as a whole as the EE department is keen on integrating peer feedback in future courses.

4.2 Method

This section describes the outline of the pilot (4.2.1.), the assignments used during the pilots (4.2.2), the participants (4.2.3), and the instruments used for evaluating the pilot (4.2.4.).

4.2.1 Structure and organization of the module writing skills within the master core courses Random signals and processes and Computational physics

The implementation of the second pilot (quartile 1, 2015/16) followed the same structure as the first pilot. This means that the instruction on writing skills was divided in three sessions in which the trainers focused on:

- Writing skills: theory and examples
- Peer review feedback given by students
- Use PEACH to upload the assignments and to upload the peer reviews as well
- Teachers' feedback during training sessions
- Trainers' feedback during training sessions

The learning outcomes of the module writing skills were:

1. Write with clear structure and logical organization of the text
2. Reproduce the problem on written form and can relate to theories, approaches and methods
3. Articulate and consider problem solving strategies to justify

4. Provide reasoning and arguments to prioritize strategies based on evaluation on appropriate theories/approaches or methods. Express this reasoning in a logical manner in written form
5. Identify and evaluate all the important results, but also some of the more abstract ones
6. Evaluate results and describes conclusions in writing on how solution can be used in other situations

In addition, the same type of material for peer feedback was used, i.e. rubrics and criteria lists, although this was contextualized according to the learning outcomes and assignment of each specific course (see appendices 10 and 11).

In addition, we also encouraged students to consult the information provided in the e-platform SkillsLab where information on writing academic paper is available. The frequency of consolation depends on the students. This has not been monitored.

4.2.2 Assignments

The written assignments consisted of the homework exercises that the students must submit to the responsible teachers on weekly basis. For the purpose of this pilot we asked the students to work on the assignments in week 2, 4 and 6. The rationale behind this was to have a series of assignments upon students can work, provide feedback and use the feedback to apply and improve the following assignments.

The students provided feedback following the criteria specific for each assignment (see Appendices 11 and 12). Both the criteria as well as the rubrics have been developed together with the teachers of the core course to assure:

1. Assessments are linked to learning outcomes;
2. Assignments are linked to the assessment criteria;
3. Criteria meets the learning outcomes;
4. Both students, trainers and teachers follow the same criteria to give feedback and to assess the assignments.

4.2.3 Participants

The module Writing Skills is a compulsory course for all master students since the academic year 2015/2016. This course is offered three times a year. For this pilot twelve students have enrolled for the module writing skills which is integrated in the master core courses Computational physics (sis students) and Random signals and processes (six students).

4.2.4. Instruments

To investigate whether the new elements integrated in the master core courses were successful we developed research instruments such as semi-structure lists with questions for interviews with teachers as well as the questionnaires for students. The questionnaires included items regarding the quality of the training content and educational materials, the peer feedback training and the assignments, the feedback given by the trainers, and finally, the feedback given by the teachers (see Appendix 12).

4.3 Results

4.3.1 Random signals and processes

With regards to the online platform 'PEACH', students are satisfied with this e-platform that facilitates the process of uploading documents but also to give peer feedback (see Table 8).

Table 8. Questions related to students' opinions on the e-platform PEACH

	Questions	Mean	SD
1	Is PEACH a suitable online platform for the peer review?	5,8	,41
2	Is PEACH useful?	5,5	,83

Regarding 'peer feedback' we observed that students are satisfied with the feedback received from co-students but also with the feedback provided by the teachers (see Table 9). However, students are less satisfied about how this peer feedback supported them to improve the writing skills. When it comes to what the students learned from giving feedback, the students' perceptions are not relatively high. But they are satisfied about the fact that by giving feedback made them become more critical about their own work.

Table 9. Students' opinions on peer feedback

	Questions	Mean	SD
1	Peer feedback you receive from your colleagues/students was good	4,1	,41
2	The peer feedback I received from my colleagues helped me to improve my writing skills	3,3	1,3

3	How valuable was the feedback you received from the technical course teachers?	5,1	1,1
	Questions on learning benefits to give feedback	Mean	SD
1	I learned to give goal-oriented, constructive and specific feedback	3,8	,13
2	I learned to become more critical about my own work/assignments	5,5	,54

In reference to students' opinions on the feedback received from the trainers, students are positive about the feedback and that this was helpful to improve the writing skills of the students (see table 10).

Table 10. Trainers/Lecturers' of the module writing skills feedback

	Questions	Mean	SD
1	Trainers'/Lecturers' feedback you receive was good	5,3	,81
2	Trainers'/Lecturers' feedback I received helped me to improve my writing skills	5,1	,75

In Table 11 we observed that students are relatively satisfied with the feedback provided by the teacher during the training on writing skills. In this case, the intervention of the teacher consisted of one time general remarks on the assignments.

Table 11. Technical course teachers' feedback

	Questions	Mean	SD
1	Teachers' feedback you receive was good	4,5	,83
2	Teachers' feedback I received helped me to improve my writing skills	4,1	1,3

Regarding the general level of students' satisfaction on the writing skills module (see Table 12), the students show positive response in that they can apply what they learned, and on the structure and setup of the course. However, when it comes to the time requested for the

completion of the assignments in comparison with the quality of peer feedback (average 4.3) the students are less positive about it. We are aware that this result may be caused by the fact that 'giving quality of feedback' is a learning process that develops and improves with time. In addition, one of the reasons for this result could also be that the assignment is based on calculations and that the students still need to transform the calculations into a logical transformation of ideas in a structured manner. Giving feedback on that issue is also a learning process.

Table 12. General students' observations on the module writing skills

	Questions	Mean	SD
1	I can apply what I have learned to improve my writing skills	5,0	1,1
2	The assignments requested too much time and effort in comparison to the quality of (peer) feedback I received on my assignments	4,3	1,2
3	The examples, slides, hand-outs and theory used were sufficient and appropriate	5,3	1,5
4	The number of lecture sessions was sufficient	5,5	,54
5	The number of assignments was sufficient	5,0	1,2

4.3.2 Computational physics

According to Computational physics students' responses on PEACH as a learning platform (Table 13), they are satisfied with PEACH as a tool to support the process to upload papers and have access to the reviews.

Table 13. Questions related to students' opinions on the e-platform PEACH

	Questions	Mean	SD
1	Is PEACH a suitable online platform for the peer review?	5,1	,75
2	Is PEACH useful?	5,1	1,1

Students' satisfaction on peer feedback is also remarkable when it comes to the level of satisfaction on the peer feedback from students, how the feedback helps to support to improve learning writing, and also the feedback by the teachers (Table 14).

When it comes to the process of giving feedback, students have learned how to give feedback. They mentioned they became critical from giving feedback (Table 14).

Table 14. Students' opinions on peer feedback

	Questions	Mean	SD
1	Peer feedback you receive from your colleagues/students was	5,1	0,9
2	The peer feedback I received from my colleagues helped me to improve my writing skills	4,8	1,7
3	How valuable was the feedback you received from the technical course teachers?	6,5	0,8
	Learn how to give peer feedback		
	Questions	Mean	SD
1	I learned to give goal-oriented, constructive and specific feedback	5,6	1,0
2	I learned to become more critical about my own work/assignments	6,0	,63

Regarding students' satisfaction on trainers' feedback on the assignments, students are satisfied (Table 15).

Table 15. Trainers/Lecturers' of the module writing skills feedback

	Questions	Mean	SD
1	Trainers'/Lecturers' feedback you receive was good	5,6	,51
2	Trainers'/Lecturers' feedback I received helped me to improve my writing skills	5,8	,98

We have observed that the students' perception on the feedback received by the teachers is also high (Table 16).

Table 16. Technical course teachers' feedback

	Questions	Mean	SD
1	Teachers' feedback you receive was good	6,3	,81
2	Teachers' feedback I received helped me to improve my writing skills	6,8	,40

Finally, we observed that students are satisfied with the whole setup of the writing skills course and what they can apply in practice from it. However, the amount of time requested to complete the assignment compared to the feedback received is to some extent lower showing the same pattern as in the Random signals and processes course (Table 17).

Table 17. General students' observations on the module writing skills

	Questions	Mean	SD
1	I can apply what I have learned to improve my writing skills	5,0	1,1
2	The assignments requested too much time and effort in comparison to the quality of (peer) feedback I received on my assignments	4,3	1,2
3	The examples, slides, hand-outs and theory used were sufficient and appropriate	5,3	1,5
4	The number of lecture sessions was sufficient	5,5	,54
5	The number of assignments was sufficient	5,0	1,2

4.3.3 Qualitative research: Interviews with the responsible teachers of the master core courses

Random signals: the responsible teacher is satisfied with the results of this pilot. Although the assignments, based on calculations, do not provide ample opportunities to report in the form of a paper, students have made efforts to reproduce the analysis of the calculations by interpreting the results, evaluating findings, projecting those in graphs and drawing sound conclusions.

Despite these positive results, the teacher indicates that some areas for further improvement are:

- Work on the context of the paper by having students to use theories on the selection of methods to solve problems
- Fine-tune the assignments in order to provide more opportunities to write reports and papers at academic level

With regards the criteria and the rubrics, the teacher considers that those are suitable instruments to guide the students in accomplishing the assignments and to implement peer review. No further adjustments are required.

Computational physics. The teachers perceive improvements in students' writing assignments especially on:

- Representing results with graphs and plots
- Analysis of results
- Explanation of theory
- Interpretation and evaluation of results
- Use of literature

However, areas which still are of concern are the introduction and the conclusion sections. Regarding the introduction, the teachers identify that the focus around the problem, how the selected approach can contribute to solve the problem, the use of theories to support the method or approach selected and the added value or relevance of the problem solution method are still lacking.

Concerning the conclusions, it is observed that it is still difficult for the students to make rough conclusions and make the point based on the result(s).

5. Conclusions and lessons learned

The innovation project *improving students' writing skills through effective small-group peer feedback* was formulated with the rationale to look for practical solutions to address the growth of number of students by introducing peer feedback. The aim was to learn how this method works in order to optimize feedback and relief the teachers' burden and supervisor's. With these two pilots we have tried to search means to intensify peer feedback in small groups to improve writing skills. In addition, we introduced PEACH as an e-tool to explore whether this platform facilitates the process of giving feedback.

From these pilots we can conclude the following:

1. Peer feedback is a suitable method to stimulate students' writing skills learning process;
2. Peer feedback, if developed appropriately, will support students to become more critical towards themselves and their work;
3. To integrate peer feedback, students need to be provided with guidelines (criteria or rubrics) in order to guide them in this process;
4. Training on how to give peer feedback is essential but also to practice. It is also important to have students to reflect upon giving feedback. These are key elements to have a proper integration of 'peer feedback' as a method.
5. Students are positive about the involvement of the teachers of their courses in giving feedback to the writing skills and assignments.
6. ICT platforms, such as PEACH, can facilitate giving feedback.

In addition, when developing the set-up of the training and working on the materials we also learned that it is of most benefits for the students to work on their writing skills when the assignments are integrated in the 'real-life' assignments they have to make to pass the courses. Students are then motivated and work towards meeting the learning outcomes of the course.

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Appendices

1. Pre and post questionnaire for student's self-evaluation of their writing skills
2. Supervisors' assessment of student writing skills
3. IEEE Rubric
4. Criteria list: outlines
5. Criteria list: introduction
6. Criteria list: method & results
7. Criteria list: conclusion and discussion
8. Criteria list: title, abstract, and IEEE guidelines
9. Evaluation questionnaire for students of pilot 1
10. Rubric/criteria list Computational physics in pilot 2
11. Rubric/criteria list Random signals and processes in pilot 2
12. Evaluation questionnaire for students of pilot 2
13. Outline concept for journal paper (still under construction)

Appendix 1 - 3TU CEE Innovation Funds

Self-Assessment: Improving Writing Skills through Peer Feedback BEP Track *'Smart & Sustainable Society and Automotive' (Before – 0 measurement) & after questionnaires*

Name student:_____ **Gender:** _____**Age:**_____

Date: 16 -04-2015 **Nationality:** _____

Have you ever followed a training course on writing skills? _____

1. **This questionnaire is intended to self-assess your writing skills before this training takes place. Please, mark the answer with an "X" you believe it best represents the current situation. 0 – Totally disagree and 7 – Totally agree**

I know how to write a short and concise title for an IEEE paper/ technical paper	1	2	3	4	5	6	7
1. I can write an abstract succinctly and straight the point							
2. I know what I have to write in the introduction section of an IEEE paper							
3. I know what the characteristics are of a good introduction							
4. I know how to organize and give structure to an IEEE paper/BEP report							
5. I can write a coherent methodology section providing overview of methods, techniques and data							
6. My (IEEE) papers illustrate scientific evidence with appropriate data that support/reject hypotheses							

7. I know how to present findings that are coherently linked to the results							
8. I know what I have to write in a discussion and conclusion section of a IEEE paper and/or technical reports							
9. I know how to describe research findings and results in an (IEEE) paper including proper use of verbs, choosing the right words, sentences and paragraphs							

2. Open questions

- **What are you good at when it comes to writing technical reports/research papers?**

_____
_____
_____
_____

- **What are your weaknesses/particular needs in writing technical reports/research papers?**

_____
_____
_____
_____

- **To what extent do you expect that this training will support you in improving your writing skills?**

_____
_____
_____
_____

Appendix 2. 3TU CEE Innovation Funds

Teachers' perceptions: Improving Writing Skills through Peer Feedback BEP Track *'Smart & Sustainable Society and Automotive'*

Name teacher/supervisor: Date: 12 -04-2015

This questionnaire is intended to assess your perceptions about to what extent has supported the training and feedback (peer feedback-trainers' feedback-experts'/teachers/supervisors feedback) to improve BEP students' writing skills. Please, mark the answer with a "X" you believe it best represents the current situation. 0 – Totally disagree and 7 – Totally agree

1. Titles of the IEEE papers/ BEP technical reports are written in a short and concise manner	1	2	3	4	5	6	7
2. Abstracts of students' IEEE papers/BEP technical reports show a succinct and straight formulation of some background info about the study conducted; purpose of the study; methods used and some important results with major conclusion or recommendation							
3. Students' IEEE papers/BEP technical reports provide a clear overview of the research problem and context in the introduction. Introduction includes research questions and hypotheses, and short summary of main results and conclusions are included							
4. Students' IEEE papers/BEP technical reports provide an appropriate overview of the methodology used including techniques, equipment, setup, analyses.							
5. Students' IEEE papers/BEP technical reports include appropriate scientific evidence based on research data. Data illustrate and provides evidence that support/reject hypotheses (e.g. explanation, evidence, examples, figures, tables and/or graphs).							

6. Students' IEEE papers/BEP technical reports include appropriate Results sections. Results are highlighted and important findings are mentioned							
7. Students' IEEE papers/BEP technical reports provide a discussion section containing a discussion on the findings and explanation of these findings							
8. Students' IEEE papers/BEP technical reports address the limitations of the research/problem/work and provides clear ideas for practice and future research							
9. Students' IEEE papers/BEP technical reports includes clear structure							
10. Students' IEEE papers/BEP technical reports paragraphs are appropriate and purposeful. There is coherence (paragraph to paragraph) and cohesion (sentence to sentence) are effectively demonstrated throughout paper. All points are logically presented and interrelated							
11. Students' IEEE papers illustrate scientific evidence with appropriate data that support/reject hypotheses/problem/work							
12. Students' IEEE papers/BEP technical reports are of good/acceptable writing quality. Papers set clearly purpose of paper through introduction or overview. There is effective conclusion that relates to introduction and unifies the writing							
13. Students' know how to describe research findings and results in an (IEEE) paper including proper use of verbs, choosing the right words, sentences and paragraphs							

3. Open questions

- **What are students' weaknesses/particular needs in writing technical reports/research papers?**

_____
_____
_____
_____

- **What are your expectations of this training regarding students' improvement in writing skills?**

_____
_____
_____
_____

Appendix 3 - Rubrics Writing Skills BEP - Quality of organisation of the paper

Criteria	Excellent	Good	Unsatisfactory	Poor
Organization & structure	♦ Structure is clear**.** Content is organized in sections and subsections with particular message/content. ♦ Readability and coherence (paragraph to paragraph) and cohesion (sentence to sentence) are purposefully demonstrated throughout paper.	♦ Structure is not always clear. Content is not always organized in sections and subsections with particular message/content. ♦ Readability and coherence (paragraph to paragraph) and cohesion (sentence to sentence) are demonstrated in general.	♦ Structure is not clear. ♦ Content does not flow smoothly and sections and sub-sections show a disruptive progression of ideas.	♦ Structure is missing. There is no coherency. Limited evidence of appropriate paragraphing. ♦ Paper is not easy to read and it lacks coherent (paragraph to paragraph) or cohesion (sentence to sentence).
Introduction provides general to specific information	♦ The introduction provides a clear overview of the research problem/context. ♦ Overview of existing state-of-the-art literature is mentioned. ♦ The research question/problem or theme and hypotheses/context are relevant to the research topic. ♦ The research aims and questions are clearly stated and follow from the introduction. ♦ The introduction includes a short overview of the	♦ The introduction provides an overview of the research problem but is not linked to a context. ♦ The research question/problem and hypotheses/context are not clearly described. ♦ The research aims and questions are not always clearly stated. ♦ The introduction an incomplete includes a short overview of the structure of the remaining part of the paper.	♦ The introduction does not provide a clear overview of the research topic/problem/ context. ♦ The research question/problem and hypotheses/context are not clearly mentioned. ♦ The research aims and questions are not mentioned. ♦ The introduction includes does not overview of the structure of the remaining part of the paper.	♦ The introduction does not provide a clear overview of the research topic/problem/context. ♦ Little of no information is given about the research problem and context. ♦ There is no research aim or questions. ♦ There is no clear overview of the structure of the remaining part of the paper.

	structure of the remaining part of the paper.			
Method & results -Scientific evidence (Presenting scientific data)-	♦ Method section clearly describes how the research is carried out including techniques, equipment, setup, analyses. ♦ If the paper focuses on describing and applying a model, the model is clearly described and all variables and all symbols are introduced and explained. ♦ Presentation technical information: meaning of figures/equations is logically explained in the text. Axes and information are well indicated in tables/figures, etc. ♦ Data (e.g. explanation, evidence, examples, figures, tables and/or graphs) illustrates and provides evidence that support/reject hypotheses/problem/work. ♦ Results are clearly highlighted and important findings are discussed.	♦ Method section describes how the research is carried out including techniques, equipment, setup, analyses. ♦ If the paper focuses on describing and applying a model, the model is clearly described and most variables and most symbols are introduced and explained. ♦ Presentation technical information: meaning of figures/equations is not always logically explained in the text. Axes and information are not always well indicated in tables/figures, etc. ♦ Data (e.g. explanation, evidence, examples, figures, tables and/or graphs) is provided but is not fully linked to support/reject hypotheses/problem/work.	♦ Method section describes how the research is carried out but no overview of techniques, equipment, setup, analyses used, is mentioned. ♦ If the paper focuses on describing and applying a model, the model is described in a procedural manner and some variables and symbols are explained. ♦ Presentation technical information: meaning of figures/equations rarely is not logically explained in the text. Axes and information are rarely indicated in tables/figures, etc. ♦ Data (e.g. explanation, evidence, examples, figures, tables and/or graphs) is provided but is not fully linked to support/reject hypotheses/problem/work.	♦ Method section does not include how the research is carried out. ♦ If the paper focuses on describing and applying a model, the model is hardly described and variables and symbols are hardly introduced. ♦ Presentation technical information: meaning of figures/equations is not logically explained in the text. Axes and information are not indicated in tables/figures, etc. ♦ Data (e.g. explanation, evidence, examples, figures, tables and/or graphs) is not reliable and does not provide evidences. ♦ Results do not include important findings. ♦ There is no evidence of data selection.

	♦ There is evidence of data selection; data is presented in a quantitative and qualitative manner.	♦ Results are highlighted and important findings are mentioned. ♦ Data is no complete.	♦ Results are highlighted but important findings are not mentioned. ♦ There is not clear evidence of data selection.	
Discussion	♦ Limitations are addressed properly. ♦ The discussion section provides clear ideas for practical and future research. ♦ Points to reconstruct experiments/algorithms are mentioned.	♦ Limitations are not always addressed clearly. ♦ The discussion section provides some ideas for practice and future research. ♦ Points to reconstruct experiments/ algorithms are not always mentioned.	♦ The discussion section addresses limitations, but too overly (reader might wonder, why research was conducted the way it was). ♦ The discussion section provides some ideas for practice and future research. ♦ Points to reconstruct experiments/ algorithms are barely mentioned.	♦ The discussion section does not provide limitations, implications or recommendations for future research for or practice. ♦ Points to reconstruct experiments/ algorithms are not mentioned.
Conclusions	♦ The conclusion paragraph sums up what has been researched and found. ♦ All main findings described can be verified within the paper and new information is described.	♦ The conclusion paragraph sums up very briefly what has been researched and found. ♦ Some findings described can be verified within the paper and some o new information is described.	♦ The conclusion paragraph sums up or repeats what has been researched and found. ♦ Some main findings described can be verified within the paper but no new information is described.	♦ The conclusion paragraph does not sum up what has been researched and found. ♦ Findings described cannot be verified within the paper and no new information is described.
Referring to others	♦ References are included and align with IEEE guidelines. It is always clear whether claims are of	♦ References are included and mostly it is clear whether claims are of the author himself or based on former studies.	♦ References are occasionally included, but often it is unclear whether claims are of the author	♦ No references are included.

	the author himself or based on former studies.		himself or based on former studies.	
Total score				

Rubrics Writing Skills BEP Track - Quality of lay-out and grammatical aspects

Criteria	Excellent	Good	Unsatisfactory	Poor
Sentences and paragraphs	♦ Each paragraph has one goal, which is described in its first sentence. ♦ Usage of good sentence construction. ♦ Paragraphs indicate shift in thought and are used to make sequence of events clear. ♦ Use of verbs (past/present) is properly used to express findings.	♦ The majority of paragraphs have one goal, which is described in its first sentence. ♦ Simple and more elaborated sentences are used. ♦ Some paragraphing to show sequence of events/ideas. ♦ Use of verbs (past/present) is sometimes properly used to express findings.	♦ Some paragraphs have one goal, which is described in its first sentence. ♦ Sentence structure is usually correct. ♦ Simple sentences are used. ♦ Little attempt made to paragraph writing. ♦ Use of verbs (past/present) is barely properly used to express findings.	♦ Paragraphs have more than one goal and lack a clear first sentence. ♦ Sentences do not make sense. ♦ No paragraphing. ♦ Use of verbs (past/present) is not properly used and has no relation to express findings.
Word choice	♦ Words are used correctly and precisely. ♦ Words are technologically appropriate.	♦ Acceptable vocabulary. ♦ Words are technologically appropriate.	♦ Simple vocabulary. ♦ Words are not technologically appropriate.	♦ Incorrect words/vocabulary. ♦ Words are not technologically appropriate.
Spelling	♦ Spelling is correct, including complex and irregular words.	♦ Spelling is generally accurate.	♦ Frequent spelling errors.	♦ Spelling errors interfere with understanding.
Punctuation	♦ A range of punctuation including commas, apostrophes, colons and semicolons is used accurately and effectively.	♦ Punctuation is used almost correctly.	♦ Frequent punctuation errors.	♦ Insufficient or lacks punctuation. ♦ Incorrect use of capital letters.
Total score				

Appendix 4 - Criteria to assess Outlines for BEP reports

Criteria	Description of the criteria	Comments by peers
General impression	• The outline gives a general idea about the organization of the paper • The sections follow an organized structure • The outline is carefully organized and presented with set of data with objectives, hypothesis and conclusions	
1. Why did I do this work? What does it mean?	The outline • gives an orientation about the relevance of the work • mentions why and for who is this paper/research important	
2. What hypothesis did I mean to test?	The outline • mentions what the hypothesis are • presents the context to select this hypothesis • explains why this hypothesis are relevant for this research/paper	
3. Which ones did I test and how?	The outline • provides an overview of the methodology used • explains why this methodology is suitable to test the hypothesis	
4. What were the results?	The outline • includes the results • explains the results and the link with the hypothesis/main research questions	
5. Did the work yield a new method of compounds?	The outline • provides a summary of the main findings • includes an overview of the findings relevant for the field	
6. How were they characterized? ▪ Sketch possible equations, figures and schemes	The outline • includes an overview of the graphs, tables, figures, etc. to support the findings • presents the graphs, tables, figures, etc. in the appropriate sections	
Abstract (is written later)		

Appendix 5 - Criteria to assess the Introduction section in IEEE papers

Criteria	Description of the criteria	Comments by peer
From general to specific	The introduction is written in such a way that readers are introduced in the topic by: - first getting an idea about the topic and context of the research problem/setup; - then presenting why the research is conducted, and how has been conducted.	
Objectives and justification	The introduction provides • about field or research-context for problem • information about aspects of problem • indications for more investigation – creating a gap to present study • purpose/objectives of writer's study or outlining its main activity or findings • positive a positive value or justification for study • the introduction mentions why this research is important	
Background	The introduction presents clearly: • what other similar research has been conducted and how? • what the methodology is; • major elements/findings of that research.	
Summary/conclusions	The introduction expresses clearly: • a short summary of the research/focus of the paper; • main conclusions and what the readers' expectations are about the research	
Verbs and grammar is properly use	In the introduction verbs are used: • in present tense to introduce information and statements which are true • in present perfect tense to express events that started in the past and are still happening or are still true for events that were completed in recent past	

Appendix 6. Criteria to assess the Method and Results sections in IEEE papers

Criteria	Description of the criteria	Comments by user
METHODS		
Organization of method	The method section is organized, for example with headings.	
Credibility	The method section details enough information such that readers can follow and understand what has been researched and how, in relation to the findings.	
Concise and informative	The method section clearly describes what has been done and how.	
RESULTS		
Organization of results	The results section is logically organized, for example it follows the hypotheses.	
Data presentation	Data are presented in the most appropriate form, for example with a table or a figure. Captions of tables/figures clearly describe the content of the table/figure, and explain additional information such as symbols. The text is descriptive, rather than discussing All tables and figures are referred to in text.	
METHODS AND RESULTS		
Style of writing	The voice of writing is rather passive than active. Passive and active wording is not mixed. Present and past tense is used appropriately (e.g., when referring to former studies, past tense is used, when referring to tables/figures, present tense is used).	

Appendix 7. Criteria to assess the Discussion section, title, and abstract in IEEE papers

Criteria	Description of the criteria	Comments by user
DISCUSSION SECTION		
Structure	The discussion section contains the elements (a) a reference to the aims of the study or a short summary of the study (b) discussion of the findings, relating them to the hypotheses and former studies (c) explanation of the findings (d) limitations, implications and recommendations for future research and/or practice.	
Strength of claims	The verbs that express the strengths of claims are well chosen.	
TITLE		
Informative	The title informs the reader about the content of the paper	
Concise	The title's information is concise and does not contain ambiguity in noun phrases	
ABSTRACT		
Summarizing the paper	The abstract summarizes the paper by addressed the following elements: (a) some background info about the study conducted (b) a statement containing the principal activity or purpose of the study (c) some info about the methods used (d) the most important results (e) a statement containing the major conclusion or recommendation	

Appendix 8. Evaluation questionnaire for students of pilot 1

Name trainers: Sonia Gomez Puente & Marieke Thurlings
Date: 28 -05-2015

Please, mark the answer with an "X" you believe it best represents the current situation.
0 – Totally disagree and 7 – Totally agree

A. Questions about the training

1	I can apply what I have learned to improve my writing skills	1	2	3	4	5	6	7
2	The assignments requested too much time and effort in comparison to the quality of (peer) feedback I received on my assignments							
3	The examples, slides, hand-outs and theory used were sufficient and appropriate							
4	The number of training sessions was sufficient							

- What is your opinion on the topics addressed in the training?

Training Session 1

1	Writing an Outline	1	2	3	4	5	6	7
2	Writing the Introduction • Objectives and justification • Background • Summary & conclusions							

Training Session 2

1	Writing the methodology section • Organization • Credibility • Concise & informative	1	2	3	4	5	6	7
2	Writing the results section • Presenting results • Style of writing							

Training Session 3

1	Writing the conclusion/discussion section • Structure • Strengthen of claims	1	2	3	4	5	6	7
2	Writing the title and abstract • Informative & concise Abstract • Summarizing the paper							

B. Peer feedback, trainers' feedback and experts' feedback

Peer feedback

1	Peer feedback you receive from your colleagues was	1	2	3	4	5	6	7
2	The peer feedback I received from my colleagues helped me to improve my writing skills							

Please mention why the feedback was/was not instructive

Trainers' feedback

1	Trainers' feedback you receive was	1	2	3	4	5	6	7
2	Trainers' feedback I received helped me to improve my writing skills							

Please mention why the feedback was/was not instructive

_____

_____

Expert feedback

1	Experts' feedback you receive was	1	2	3	4	5	6	7
2	Experts' feedback I received helped me to improve my writing skills							

Please mention why the feedback was/was not instructive

_____

Open questions

- What is the most valuable aspect of this training course?
- What is the least valuable aspect of the training course?
- What did you miss in the training course?
- Do you have any remarks or suggestions to improve this course?

Appendix 9. Rubrics Writing Skills Rubrics Writing Skills 'Computational Physics'- Quality of analysing & writing results of assignments

Criteria	Excellent (10-9)	Good (8-7)	Fair (6- ≤5.5)	Unsatisfactory (≥5.4)
Introduction	• References to context of the problem/topic theories/approaches/methods are mentioned • Similar work in the field conducted and how references to other work is mentioned • Added value of addressing this topic/problem within the field in comparison to similar work	• References to context of problem/topic theories/approaches/method are generally mentioned • Similar work in the field conducted and how references to other work is briefly mentioned • Added value of addressing this topic/problem within the field in comparison to similar work is generally mentioned	• References to context of the problem/topic theories/approaches/ methods are mentioned but are not relevant • Similar work in the field conducted and how references to other work is wrongly mentioned • Added value of addressing this topic/problem within the field in comparison to similar work is not relevant	• References to context of the problem/topic theories/approaches/methods are not mentioned • Similar work in the field conducted and how references to other work is not mentioned • Added value of addressing this topic/problem within the field in comparison to similar work is not mentioned
Presenting results	• In presenting results, theory/approach or method are used to explain how the problem/case has been solved • Results, arguments or procedures are explained and justified	• In presenting results, theory/approach or method is generally used • Arguments or procedures are explained and justified but are little related to the results	• In presenting results, theory/approach or method is briefly used • Arguments or procedures are explained and justified but are not relevant to the results	• In presenting results, theory/approach or method is not used • Results, arguments or procedures are not explained and justified
Presenting evidence with data	• Data is used to interpret, clarify meaning and results • Tables/figures/ are discussed in the corresponding text. • Captions of tables/figures clearly describe the content of the table/figure, and explain additional information such as symbols. • All tables and figures are referred to in text.	• Data is used to interpret, clarify meaning but there is no always direct link to results/problem • Tables/figures/ are discussed in the corresponding text but there is no always direct link to results/problem • Captions of tables/figures do not always clearly describe the content of the table/figure, and explain additional information such as symbols.	• Data is used to interpret, clarify meaning but is not relevant to the results • A table/figure/ is discussed in the corresponding text. • Captions of tables/figures clearly describe the content of the table/figure, and explain additional information such as symbols. • A few tables and figures are referred to in text.	• Data is not used to interpret, clarify meaning and results • Tables/figures/ are not discussed in the corresponding text. • Captions of tables/figures do not describe the content of the table/figure, and explain additional information such as symbols. • All tables and figures are not referred to in text.

	• Codes are explained and are part of the report	• Some tables and figures are referred to in text • Some codes are explained and are part of the report	• Codes are briefly explained and not all relevant information is included as part of the report	• Codes are not explained and are part of the report
Drawing conclusions based on results	• Evaluate the results and provide arguments with the use of theory/method/approaches to draw conclusions • Choices are explained and justified: explanation on what, how and why is implemented is given • Discussion and explanation of the findings, related to the hypotheses/problem is provided. Describes how solution can be used in other situations. • Reasoning gives clear explanations of why there are mistakes/bottlenecks • Limitations, implications and recommendations for future use of algorithms in practice are given	• Some results are evaluated and only some arguments are provided with the use of theory/method/approaches to draw conclusions • Only some choices are explained and justified: briefly explanation on what, how and why is implemented is given • Discussion and explanation of the findings, related to the hypotheses/problem is briefly provided. There is little ddescription on how solution can be used in other situations. • Reasoning gives little explanations of why there are mistakes/bottlenecks • Limitations, implications and recommendations for future use of algorithms in practice are generally given	• Little evaluation of results and arguments are provided with the use of theory/method/approaches to draw conclusions • Choices are little explained and justified: explanation on what, how and why is implemented is not relevant • Discussion and explanation of the findings, related to the hypotheses/problem is barely provided. There is little ddescription on how solution can be used but this is not relevant. • Reasoning gives not related explanations of why there are mistakes/bottlenecks • Limitations, implications and recommendations for future use of algorithms in practice are not relevant	• There is no evaluation of the results and there are no arguments supported by theory/method/approaches • Choices are not explained and justified: explanation on what, how and why is implemented is given • Discussion and explanation of the findings, related to the hypotheses/problem is not provided. There is no ddescription on how solution can be used in other situations. • There is not reasoning to explain why there are mistakes/bottlenecks • Limitations, implications and recommendations for future use of algorithms in practice are not given

Rubrics Writing Skills Master course 'Computational physics' - Quality of lay-out and grammatical aspects

Criteria	Excellent (10-9)	Good (8-7)	Fair (6- ≤5.5)	Unsatisfactory (≥5.4)
Sentences and paragraphs	• Usage of sophisticated sentence patterns. • Paragraphs indicate shift in thought and are used to make sequence of events clear. • Use of verbs (past/present) is properly used to express findings.	• Simple and more elaborated sentences are used. • Some paragraphing to show sequence of events/ideas. • Use of verbs (past/present) is sometimes properly used to express findings.	• Sentence structure is usually correct. • Simple sentences are used. • Little attempt made to paragraph writing. • Use of verbs (past/present) is barely properly used to express findings.	• Sentences do not make sense. • No paragraphing. • Use of verbs (past/present) is not properly used and has no relation to express findings.
Word choice	• Words are used correctly and precisely.	• Acceptable vocabulary. • Words are technologically appropriate.	• Simple vocabulary.	• Incorrect words/vocabulary.
Spelling	• Spelling is correct, including complex and irregular words.	• Spelling is generally accurate.	• Frequent spelling errors.	• Spelling errors interfere with understanding.
Punctuation	• A range of punctuation including commas, apostrophes, colons and semicolons is used accurately and effectively.	• Punctuation is used almost correctly.	• Frequent punctuation errors.	• Insufficient or lacks punctuation. • Incorrect use of capital letters.

Appendix 10. Rubrics Writing Skills Random signals & processes - Quality of analysing & writing results of assignments

Criteria	Excellent (10-9)	Good (8-7)	Fair (6- ≤5.5)	Unsatisfactory (≥5.4)
Understanding the problem	• Understands the problem and can relate it to theories, approaches and methods	• Understands (can explain) the problem and proceeds to the next step. • Cannot always relate it to theories, approaches & methods	• Needs some clarification to understand the problem. • Uses some theories, approaches and methods in the field but not these are not always correct	• Needs a complete explanation of the problem before starting
Solving the problem	• Considers problem solving strategies. • Prioritizes strategies based on evaluation on appropriate theories/ approaches or methods	• Considers some problem solving strategies. • Decides on an appropriate solution.	• Considers some problem solving strategies. • Requires assistance to select the appropriate strategy	• Uses only one strategy. • Requires assistance to evaluate strategy
Analyzing & evaluating the results with argument	• Iidentifies and evaluates all the important results, but also some of the more abstract ones. • Designs own criteria to Evaluate results.	• Identifies and evaluates all the important results, but not the ones deeper in the theoretical background/ approaches/methods. • No criteria are given.	• Limited evaluation of solution without assistance. • Does not compare solution to problem.	• Fails to identify and evaluate any of the important results behind the theories/ approaches/methods. • Requires assistance to evaluate solution.
Drawing conclusions based on results	• Generalizes solution. Describes how solution can be used in other situations. • Reasoning but gives clear explanations of why they are mistakes.	• Explains the reason one method is better using specialized language and symbols including specific measurements or qualities. • Identifies & avoids all mistakes of reasoning & explains some of them.	• Explains what happened using terminology related to the problem. • Successfully identifies and avoids some common mistakes of reasoning but misses less common ones, and does not explain why or how they are mistakes.	• Explains what happened in simple terms. • Fails to identify and explain mistakes using arguments or reasoning.

Rubrics Writing Skills Master course Random signals & processes - Quality of lay-out and grammatical aspects

Criteria	Excellent (10-9)	Good (8-7)	Fair (6- ≤5.5)	Unsatisfactory (≥5.4)
Sentences and paragraphs	• Usage of sophisticated sentence patterns. • Paragraphs indicate shift in thought and are used to make sequence of events clear. • Use of verbs (past/present) is properly used to express findings.	• Simple and more elaborated sentences are used. • Some paragraphing to show sequence of events/ideas. • Use of verbs (past/present) is sometimes properly used to express findings.	• Sentence structure is usually correct. • Simple sentences are used. • Little attempt made to paragraph writing. • Use of verbs (past/present) is barely properly used to express findings.	• Sentences do not make sense. • No paragraphing. • Use of verbs (past/present) is not properly used and has no relation to express findings.
Word choice	• Words are used correctly and precisely.	• Acceptable vocabulary. • Words are technologically appropriate.	• Simple vocabulary.	• Incorrect words/vocabulary.
Spelling	• Spelling is correct, including complex and irregular words.	• Spelling is generally accurate.	• Frequent spelling errors.	• Spelling errors interfere with understanding.
Punctuation	• A range of punctuation including commas, apostrophes, colons and semicolons is used accurately and effectively.	• Punctuation is used almost correctly.	• Frequent punctuation errors.	• Insufficient or lacks punctuation. • Incorrect use of capital letters.

Appendix 11. Evaluation questionnaire for students in pilot 2

Name lecturers: dr. Sonia M. Gómez Puente

dr. ir. Jan Vleeshouwers

Date: 27 -10-2015

Please, mark the answer with a "X" you believe it best represents the current situation.

0 – Totally disagree and 7 – Totally agree

A. Questions about the module Writing skills

	Questions	1	2	3	4	5	6	7
1	I can apply what I have learned to improve my writing skills							
2	The assignments requested too much time and effort in comparison to the quality of (peer) feedback I received on my assignments							
3	The examples, slides, hand-outs and theory used were sufficient and appropriate							
4	The number of lecture sessions was sufficient							
5	The number of assignments was sufficient							

- What is your opinion on the topics addressed in the module?

Lecture Session 1

	Questions	1	2	3	4	5	6	7
1	Writing an Introduction							
2	Writing the Introduction • Objectives, background & context of the assignment/paper • Writing the title							
3	This part of the theory presented was superfluous							

Lecture Session 2

	Questions	1	2	3	4	5	6	7
1	Writing the methodology section • Organization • Concise & informative							
2	Writing the results section • Presenting results • Style of writing							
2	This part of the theory presented was superfluous							

Lecture Session 3

	Questions							
1	Writing the conclusion/discussion section • Structure • Strengthen of claims	1	2	3	4	5	6	7
2	This part of the theory presented was superfluous							

Learning outcomes:

Mark with a 'X" the learning outcomes you have applied during the course

	Questions	
1	Write clearly structured and logically organized	
2	Introduce a problem in written form	
3	Relate a problem to theories and methods	
4	Consider problem solving strategies	
5	Provide reasoning and arguments to prioritize strategies	
6	Identify and evaluate the important results	
7	Draw and describe conclusions	
8	Reflect on one's own writing and on other's	
9	Provide respectful feedback to others, supported by arguments	

Theory

Was the theory given in this course useful to learn some basics on academic writing?

Practice

	Questions	1	2	3	4	5	6	7
1	Did the exercise correspond to the theory?							
2	Were the exercises suitable for the training?							
3	Is the amount of work required for this module according to the number of hours (28h.)							

PEACH

	Questions	1	2	3	4	5	6	7
1	Is PEACH a suitable online platform for the peer review?							
2	Is PEACH useful?							

Please, give your opinion about PEACH

Worked fine for me.

PEACH website is sufficient, but we can't download the report from it, it's inconvenient for us to comment.

Teaching materials

	Questions	1	2	3	4	5	6	7
1	Are the presentations of sufficient quality?							
2	Are the presentations clear?							

Did you miss specific study material? If yes, which one?

B. Peer feedback, lecturers' of module writing skills feedback, and the course teacher's feedback

Peer feedback

	Questions	1	2	3	4	5	6	7
1	Peer feedback you receive from your colleagues/students was good							
2	The peer feedback I received from my colleagues helped me to improve my writing skills							
3	How valuable was the feedback you received from the technical course teachers?							

What did you learned from giving peer feedback to other peer students

	Questions	1	2	3	4	5	6	7
1	I learned to give goal-oriented, constructive and specific feedback							
2	I learned to become more critical about my own work/assignments							

Please mention why the feedback you got from your peer students was/was not instructive

Trainers/Lecturers' of the module writing skills feedback

	Questions	1	2	3	4	5	6	7
1	Trainers'/Lecturers' feedback you receive was good							
2	Trainers'/Lecturers' feedback I received helped me to improve my writing skills							
3	Does the trainer explain topics clearly?							
4	Does the trainer use the audio visual aids/study material properly to support learning?							

Please mention why the feedback was/was not instructive of the assignments, also gave us sufficient feedback for our reports. It's very instructive

_____

_____

Technical course teachers' feedback

	Questions	1	2	3	4	5	6	7
1	Teachers' feedback you receive was good							
2	Teachers' feedback I received helped me to improve my writing skills							

Please mention why the feedback by the technical course teacher was/was not instructive

_____

<u>Open questions</u>

Appendix 12. Concept Journal paper (Still under construction)**

1. Introduction

In a recent study conducted at the Electrical Engineering department at Eindhoven University of Technology (TU/e) among a number of teachers at the EE[6] department it has been identified that writing skills are an important academic ability that still needs considerable attention. In addition, within the framework of the Graduate School master redesign, a needs assessment survey[7] has been carried among all EE research groups. One of the major problems mentioned by the research group members were the low quality of writing skills both at technical and at academic level.

Likewise, the growth in number of students can have also some side-effects that may also jeopardize the quality of students' writing skills. Within this scenario we foresee that the teachers and supervisors are not able to pay individual attention to students' personal needs and/or that the feedback will take place in a minor scale or not at all. Although feedback is regarded in research studies as powerful educational 'weapon' we are afraid that this will not be possible unless we tackle this constraint in time.

Concerned with these findings and facts, the EE department is seriously determined to optimize students' academic writing performance both at undergraduate and graduate level. Within the department there is special interest to work on new educational methods that can allow effective supervision by researching options to organize peer feedback. We conducted two studies to research the effects of peer feedback provided on writing skills both at bachelor and master level. Our research questions were: to what extend does peer feedback can improve students' writing skills while writing IEEE papers? What are master students' perceptions on peer feedback and on providing online feedback?

Our findings indicate gains while comparing before-after study in writing skills of bachelor's students' final project. Likewise, we also find significant differences in same aspects investigated such as 'I know how to write a short and concise title for an IEEE paper/technical paper'; 'I can write an abstract succinctly and straight to the point'; 'I know what I have to write in the introduction section of an IEEE paper'; 'I know what the characteristics are of a good introduction'; 'I know how to organize and give structure to an IEE paper/BEP report'; 'I know what I have to write in a discussion and conclusion section of a IEEE paper and/or technical reports'; and 'I know how to describe research findings and

[6] EE Internal short overview of teachers observations on writing skills. (2014)
[7] EE Internal report on Master Redesign (2014).

results in an (IEEE) paper including proper use of verbs, choosing the right words, sentences and paragraphs'.

2. Theoretical framework

Peer feedback and peer assessment in higher education have been described as powerful tools to foster students' educational development [8]. Although there is extensive literature on feedback there is less information on peer feedback and peer assessment methods in higher education and more specifically in engineering education and bèta education. Furthermore, there is substantial research regarding formative and summative feedback but when it comes to optimizing students' learning in academic writing there are little evidences about the approaches which work[9]. Grounded in the existing literature, formative assessment as 'assessment *for* learning' occurs when teachers use inferences about student progress to inform their teaching. In this regard, methods such as frequent, formal or informal (e.g. quality questioning, anecdotal notes, written comments), embedded in teaching supports, providing clear and timely feedback, that helps students in their learning progression. In this respect, the formative character and use of these techniques provide evidence that informs, or shapes, short term planning for own learning and self-directed learning.

Other approaches to boost peer feedback and peer assessment are based on having students to be actively involved in the development of own criteria, or the use of rubrics as supervision and assessment instruments.

Although there are studies showing interesting insights on peer feedback these studies are based on practical experiences rather on scientific research. There is a need to investigate further what the benefits of peer feedback and peer assessment are in students' learning while performing as effective tools to diminish teachers' supervision work.

[8] Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81–112. doi:10.3102/003465430298487
Gielen, S., Peeters, E., Dochy, F., Onghena, P., & Struyven, K. (2010). Improving the effectiveness of peer feedback for learning. *Learning and Instruction*, *20*, 304–315. doi:10.1016/j.learninstruc.2009.08.007
Sluijsmans, D. M. A. (2002). *Student involvement in assessment: The training of peer assessment skills* (doctoral dissertation*)*. Open Universiteit.

[9] Topping, K.J. (2009). Theory into Practice. 48:20-27

3. Research method

3.1. Development of self-assessment instruments: before and after measurements

Regarding the first pilot, and in order to measure the impact of the training on the expected improvement of writing skills we developed a questionnaire based on a Likert scale of 1 (totally disagree) to 7 (totally agree) to measure the starting level of the students (see appendix 1). The same questionnaire was used after the training to measure the students' gains in writing skills according to own perceptions. We analyzed students' gains by comparing the 'before' and 'after' situation to know whether there are significant differences in writing skills. In addition, we also asked students to send an example of a report written by them in previous years or quartiles. The aim was to analyze the start level of writing skills based on a real example. Furthermore, based on this analysis of writing skills, the trainers provided feedback against the expected end level and according to IEEE guidelines and criteria.

In addition to the students' self-assessment of their writing skills, a supervisors' assessment form was developed along the same kind of questions regarding the IEEE paper. The same Likert scale of 1 (totally disagree) to 7 (totally agree) was applied. Two open-ended items were added, asking for the supervisors' opinion of students' strengths and weaknesses in writing and for their expectations of the training.

We developed a rubric to assess students' writing skills, which we applied to participants' most recent writing product prior to the training and to their BEP report after the training. This rubric was developed based on the criteria of IEEE guidelines (see Appendix 4) and in consultation with four EE-lecturers. More specifically, we made a first version of this rubric which was then discussed with the four lecturers. Based on their comments and suggestions, the rubric was adapted. This second version was used during the pilot.

Additionally, based on the assessment rubric, the criteria lists were developed separate for each section of a BEP paper (i.e., outline; introduction; methods and results; conclusion and discussion; title and abstract; IEEE guidelines). These criteria lists were provided to the students over the course of the training sessions in order to support peer feedback.

We developed a questionnaire that was used to evaluate the training sessions from the students' point of view. On a 7-point Likert scale, we collected students' opinions on, for instance, their satisfaction with the four training sessions and the peer feedback. In addition, we interviewed four lecturers who supervised students who had participated in the training. For example, we asked to what extent they had noticed their students' participation in the training and to what extent students' writing skills had improved. The criteria to select the supervisors were based on:

- Previous experience in supervising BEP students at the EE department;
- Students that they supervised have followed the training on writing skills;
- Supervisors have attended the instruction meeting on how to coach and assess students' writing skills.

Regarding the second pilot, we investigated whether the new elements integrated in the master core courses were successful we developed research instruments such as semi-structure lists with questions for interviews with teachers as well as the questionnaires for students. The questionnaires included items regarding the quality of the training content and educational materials, the peer feedback training and the assignments, the feedback given by the trainers, and finally, the feedback given by the teachers.

Results

Study 1

Participants

Students of Smart Sustainable Society were invited to participate by the associate professor leading this study program. Participation was voluntary, however, some students felt they were obliged to participate. The sample consisted of 10 students (1 female, 9 male).

Procedure

[OPZET TRAINING, SESSIES, INHOUD, RUBRIC, CRITERIA LIJSTEN]

Instruments

Three instruments were applied. The first was a questionnaire, aiming to evaluate the training sessions from the students' perspective. The items concerned for example their satisfaction with the four training sessions and the peer feedback and a 7-point Likert scale of 1 (totally disagree) to 7 (totally agree) was used. Two open-ended questions were added asking their opinions about the most and the least valuable aspect of the training. This questionnaire was fill out by the students at the end of the final meeting.

The second instrument aimed to explore the impact of the training on the expected improvement of writing skills. This self-assessment questionnaire was used as a pre-training measure and filled out during the kick-off meeting. It was also used as a post-training measure and filled out during the last meeting. The 10 items were answered on a Likert scale of 1 (totally disagree) to 7 (totally agree) and asked for example: "I can write an abstract succinctly and straight the point" and "I can write a coherent methodology section providing overview of methods, techniques and data". At the pre-measure, three open-ended questions were added, asking for the student's strengths and weaknesses concerning writing and their expectations of the training. At the post-measure, one open-ended question was added: "To what extent has this training supported you to improve your writing skills?".

The third instrument aimed to investigate supervisors' perceptions of their students. Four lecturers were interviewed who supervised participating students. For example, we asked to what extent they had noticed their students' participation in the training and to what extent students' writing skills had improved.

Data-analysis
Using Kirkpatrick: 1.Reaction (with evaluation questionnaire); 2.Learning in terms of knowledge, skills and attitudes (pre/post self-assessment writing; supervisors interviews); 3. Behavior (pre/post self-assessment writing; interviews supervisors/ this level goes beyond training, what can we say about it?); 4.results (??)

Results
1.reaction
[VERSLAG VD INTERVIEWS DOCENTEN]
[EVALUATIEVRAGENLIJST STUDENTEN]

2.Learning
The results of the students' level in writing skills were measured in two different moments: start and end level.

Study 2
Context
Two Master-courses, assignments
Participants
Who the participants were, male/female, age?
Procedure
Three sessions,
Instruments
-what exactly has been done?
-PEACH evaluation
Data-analysis
Kirkpatrick. 1. Reaction (PEACH evaluation; evaluation of training?). 2.learning. (?; GEEN DATA!!!).
Results
1.reaction
[EVALUATIEVRAGENLIJST STUDENTEN]
[INTERVIEWS LERAREN]
Conclusion/discussion/lessons learned
…
Conclusion/discussion

Short summary of studies; answering research questions. Discuss the findings, confirming, contributing? Future research; implications for practice.