Student and supervisor understanding of generic criteria for specific projects – A pilot study in an engineering education context

Student and supervisor understanding of generic criteria for specific projects – A pilot study in an engineering education context

Magnus Gustafsson, Jessica Dagman, Jonas Fredriksson, and Rasmus Rempling
Chalmers University of Technology

This paper offers an account of a pilot investigation into students' and supervisors' understanding and interpretation of university-wide guidelines and criteria for theses in engineering education. The university-wide criteria present both a means and a challenge for enhancing theses quality. To the extent that the means lies in indicating the expected standard, the challenge lies in the difficulty to interpret criteria relative specific student projects in order to decide what the criteria imply for specific engineering disciplines and projects. Consequently, there is a risk that despite articulating guidelines and criteria, the quality of theses does not improve since the discipline's standards are insufficiently articulated by supervisors and internalised by students. We suggest that revised supervision processes promoting student ownership and their informed engagement in criterion-based self- and peer-assessment might offer ways of promoting disciplinary discursive expertise for internalising standards by addressing the difficulty of understanding assessment criteria.

Keywords: Engineering education, Criteria-based rubric-articulated assessment, Rubrics.

Introduction

As most colleagues in Swedish higher education will probably have experienced in the past few years during their respective university programmes' external audit from the Swedish National Agency for Higher Education, thesis quality is the decisive factor and externally articulated general criteria are rarely transparent. In other words, most of us have experienced the challenge of interpreting criteria that are meant to be valid across a vast range of activities and disciplines. For our students, thesis guidelines, come with criteria that are also more or less general and it seems likely that students struggle to understand and interpret these criteria unless the criteria are already familiar to them. We have probably also experienced assigning a task along with assessment criteria in the belief that criteria are understood. From the point of view of thesis supervision, at Master and Bachelor levels definitely, this is likely the learning environment we expose our students to. If faculty find the process of understanding external criteria demanding, it seems we need to investigate what the corresponding process for our students is like and, if possible, how to enhance criteria understanding to promote thesis quality.

This study draws on discussions with supervisors who supervised theses during the 11/12 and 12/13 academic years and involves faculty-training groups at Master of Science (MSc) and Bachelor of Engineering (BEng) levels. Our focus is the work supervisors have been doing to interpret university-wide guidelines and criteria and thus contextualize them for their respective disciplines and projects (Malmqvist, Wedel, & Enelund, 2011). The guidelines that are in use at Chalmers University of Technology (Chalmers) initially focused

on procedural issues, but now also provide criteria presented with three-level rubrics (MSc guidelines, BEng guidelines). The study also mentions some of the learning activities designed and implemented by the supervisors in their attempts to unpack this set of general criteria. Despite the influence of the external audit and in line with an effort towards constructive alignment at Chalmers (Adawi, T., Gustafsson, M., Saalman, E., Stehlik, T. & Thew, N., 2011), these activities have a formative focus rather than a focus on the certification process.

We have explored reshaping assessment from being an activity where teachers exercise judgment on students, to it prompting self-regulated learning for both short-term and continuous learning goals (Boud 2012, Boud and Falchikov 2006; Crisp 2012; D. Hounsell, MacCune, J. Hounsell, & Litjens, 2008; Macfarlane & Dick 2006). This shift starts with student ownership and understanding of the standards of their respective disciplines and hence their influence on and negotiation of assessment criteria. We believe that when such a shift happens, assessment begins to support 'self-regulated learning', which, following Boud (2012), is a crucial step in creating sound formative assessment that is student-centred and fit for modern higher education.

This paper presents our conversation about criterion-based supervision in engineering and observations about criteria articulation and interpretation among student and supervisors. Observations also include some lessons learned through experimenting with collective supervision. Through our reflection, we also hope to be able to contribute to research and development into the adaptation of generic criteria beyond our limited sphere of influence at Chalmers University of Technology.

The presentation is structured around pilot-sized endeavours to explore supervisor and student understanding and articulation of criteria. However, the paper opens on a brief account of our methodological approach and proceeds to offer a selective review of some of the literature on assessment. We close on a short discussion to comment on some of the results we believe we see and some of the lessons learned from the data analysis and the supervisors' observations.

Brief background to criteria-based, rubric-articulated assessment

In line with most educational research and with many educational policies, European higher education has been moving towards a more student-centred approach to teaching for several years (see e.g., Hyland, Kennedy, & Ryan, 2006). This move is true also for assessment procedures where assessment *for* learning rather than *of* learning is now more frequent (Hounsell et al. 2008; Nicol 2010; O'Donovan, Price & Rust, 2008; Rust, Price, & O'Donovan, 2003). An increasingly frequent assessment procedure in discussions of assessment for learning is *criteria-based assessment*. Such assessment is often communicated by means of a rubric, which is 'a grid of assessment criteria describing different levels of performance associated with clear grades' (Reddy & Andrade 2010, p. 435). The essential argument is that transparent criteria are powerful for communicating both grades and learning tasks in a transparent manner thus clarifying what is expected of students (Cf. Biggs & Tang, 2007). This transparency, when present, is critical for assessment *for* learning and, hence, for deep approaches to learning (see e.g., Nicol & Macfarlane-Dick 2006; Reddy & Andrade 2010; Yorke 2003).

However, there are also studies on criteria-based assessment indicating problems. For example, Sadler (2005) finds that our preference for criteria and rubrics has escalated the use of these but left the methodological understanding of how to make effective use of criteria and rubrics behind. There is also risk that uncritical use of criteria might result in less autonomous students since overreliance on criteria can undermine students' ability to adapt transferable skills and act independently in terms of life-long learning (Boud & Falchikov 2006, p. 403). A similar problem with criteria is the relative level of detail selected, where

Torrance (2007) criticises the assessment practice where criteria become too detailed since such practice risks turning criteria into checklists rather than tools for developing learning strategies (cf. also Nicol & Macfarlane-Dick, 2006). This lacking methodological agreement also risks generating assessment practices where criteria via standardised forms minimise feedback on a specific assignment; and that, consequently, students find criteria-based assessment too general and vague to promote learning (Bailey, 2009). Bailey (2009) suggests that this vacuous assessment situation represents teacher perceptions and lacking understanding of criteria, which in turn leads to impoverished learning environments with no explicit link between assignments and assessment.

In light of the criticism against criteria-based assessment, there is a need for further work on how supervisors and students approach, react to, and understand different practices and activities for articulating and negotiating criteria (although see Cramp, 2011; Hounsell et al. 2008; Rae & Cochrane, 2008; Weaver, 2006; O'Donovan, Price & Rust 2008 for useful studies). Such knowledge is crucial for a better understanding of how supervisors and students can work efficiently and in learning-oriented formative ways with criteria-based assessment of degree theses. We also believe that such practices might enable more sophisticated assessment, involving student ownership and self-regulating dimensions in their learning (Boud & Falchikov, 2006; Crisp, 2012; Hounsell, et al 2008; Macfarlane & Dick 2006; Nicol, 2010; O'Donovan, Price & Rust 2008).

Action research set-up

The methodology of the study is action research in the sense that it represents 'deep inquiry' into the supervisory practices of the authors (Riel, 2010) through systematic, reflective study of empirical evidence (cf. also Kember, 2000; Norton, 2009). Since our practice is the supervision of Master of Science students and Bachelor of Engineering students, we have collected data, by convenience sampling only, on the various stages of such supervision during the spring term 2012 for a limited number of students in order to re-design supervision for the 2012/2013 academic year and onwards.

Following Riel (2010), this study follows an action research set-up where each cycle consist of four steps: (1) *study and plan* – (2) *take action* – (3) *collect and analyse evidence* – (4) *reflect* (See also Norton 2009). This article presents the first cycle, with an emphasis on steps 1 and 2 and a limited amount of data collection due to the supervisory situation of the authors. In many ways, the paper itself documents our 3rd and 4th steps. In this action research cycle, we have used an ongoing conversation over eight 3-hour meetings about informed criterion-based supervision, data from other supervisors, and student data in order to begin to shed light on the following research questions:

- How do supervisors and students in engineering programmes at Chalmers integrate and act on university-wide criteria for theses such as the ones distributed at Chalmers since 2008?
- What can supervisors and students do to enhance thesis quality through criterion-based supervision and revision?

For the collection of data and the analysis of it, we have triangulated methods of generating data but the analysis remains initial at this point. For instance, supervisors have been responsible only for their own data so far. The types of data available at this stage include fellow supervisors' articulation of criteria understanding; student reflections on criteria (self-articulated rubrics for self- and peer assessment), workshop presentation material, and theses; supervisor observations and interviews as well as and the continuous and reflective negotiation of criteria in the supervisor group. This article focuses on 12 fellow supervisors' articulation of one criterion for the MSc thesis, 13 MSc students' articulation of the same criterion during an introductory workshop for the thesis projects; 6 Master of Science students' re-articulation of the same criterion in a focus group interview, and 10 Bachelor of

Engineering students' interpretation of their corresponding criterion as articulated through self- and peer assessment in a late-stage peer-review seminar.

Methodological and ethical considerations

Due to the limited number of students, the study is predominantly reflective and there is no meaningful quantitative analysis. Data was collected from 12 supervisors in structural engineering during a workshop activity among supervisors. They were asked to articulate their understanding of a specific criterion and write it down on post-it notes. We next collected samples of 13 Master of Science (MSc) students' understanding of the same criterion via a workshop and also interviewed 6 of these in a focus interview. Our third set off data consists of 10 Bachelor of Engineering (BEng) students' understanding of their corresponding criterion for the BEng thesis via their self- and peer assessment of late-version theses drafts. A fourth set of data comprises the synthesised observations of the supervisors in the ongoing conversation. Content analysis of these four sets of data has been conducted by two of the authors but only superficial validation of the analysis has been performed in our peer reading of analyses. The study does not include control groups with different learning activities and assessment procedures to allow for what Denzin (2009, p. 301) refers to as triangulation over 1) time, 2) space or 3) person. Our results, therefore, preliminary and require further research among our colleagues over an extended period of time. The ethical considerations of the study involved obtaining written permission to use student work for research purposes.

Supervising degree theses in engineering: Unpacking criteria and understanding rubrics

Since 2008 Chalmers University of Technology has distributed university-wide guidelines for degree theses. From initially focusing on procedural issues, these guidelines now also provide criteria, which, in turn, are unpacked in three-level rubrics (MSc guidelines, BEng guidelines). The documents articulate the criteria as learning outcomes but for the purposes of this paper we will try to disambiguate and focus on criteria and rubrics. The scope of the paper, as well as the pilot study, does not allow equal detail on all criteria and we choose to focus here on one of the MSc criteria only (Table 1).

Criterion 4 of the MSc thesis guidelines has the following articulation and rubric levels for 'very high quality' (VHQ), 'high quality' (HQ), and 'insufficient quality' (IQ), respectively:

Table 1: MSc criterion 4

	4. Ability to identify, formulate and manage complex problems in a critical, independent and creative manner from an overall perspective
VHQ	The project has a clear and delimited problem or formulation of objectives. The problem/formulation of objectives has been studied in an adequate, critical and reflective manner. There is a clear connection between the problem/formulation of objectives, results, discussion and conclusions. The project's conclusions are well supported and correct.
HQ	The project has a clear and delimited formulation of the problem. The problem has been studied in an adequate manner. There is a clear connection between the problem, results and conclusions. The project's conclusions are well supported and correct.

IQ	The project does not have a clear problem or formulation of objectives or this is lacking altogether. Irrelevant method(s) used. The project does not present an answer to the problem or a result that is related to the objective. Conclusions are incorrect.

For the BEng guidelines, criterion 2 comes close to the MSc fourth criterion and it is the criterion we used in the workshop activities. However, for the BEng guidelines, the second criterion also includes aspects of critical evaluation of solutions, which corresponds to MSc criterion #6:

Table 2: MSc criterion 6

	6. Ability to create, analyse and critically evaluate different technical/architectural solutions
VHQ	The project produces new solutions that are analysed and evaluated in a critical manner. Alternative solutions have been produced and treated in a relevant and exhaustive manner.
HQ	The project produces solutions that are analysed and evaluated in a critical manner.
IQ	The project has not documented or presented as indicated above in a clear manner. [sic]

Since we try to compare the ways in which both MSc students as well as BEng students understand or articulate an understanding of this overlapping criterion we need to refer to both MSc criteria 4 and 6 as we discuss the BEng students' phrases from their workshop.

Supervisors' and Master of Science students' understanding and articulation of criterion 4

In a workshop with 12 fellow supervisors, we asked them to articulate their understanding of MSc criterion 4 via a series of brief writing tasks on post-it notes. We subsequently asked 13 MSc students to write down their pre-project understanding of the same criterion during an introductory thesis project seminar. Six of these students were interviewed in a focus interview to verify our initial analysis of the answers. Our analysis suggests that there is overlap in articulations but also that there is a risk in interpreting that overlap as agreement in understanding.

Table 3 offers one way of presenting the criterion articulation data from the supervisors and MSc students. When analysing the answers of the supervisors and MSc students, the general conclusion is that 46 answers of 70 are related to an understanding of the criterion, while 24 are related to mere reformulation, explaining words or giving no answer at all. From the answers related to understanding two general views can be extracted: a practical view, i.e. what should be done to either show or present that the criterion has been meet; and an abstract view, i.e. how the criterion should be treated/handled by the student. Both supervisors and students gave practical and abstract answers. However, the result indicates that 14 of 22 offered abstract explanations and this appear to view the criterion from an abstract perspective. The students, however, while the students assume more practical explanations as 15 of 24 student articulations were practically oriented (Table 3).

Table 3: Overview of supervisor and MSc student articulation of criterion 4

View (Sup./M.Sc.)	Identify	Formulate	Manage	Critical/Creative	Independent	SUM

Practical	2/2	1/5	3/6	2/1	-/1	8/15
Abstract	-/2	-/1	6/1	6/4	2/1	14/9
Reformulate	4/3	2/2	-/1	2/-	-/-	8/6
Word expl.	-/2	1/-	-/2	-/-	-/-	1/4
No ans.	-/-	-/1	-/-	-/4	-/-	-/5
SUM	6/9	4/9	9/10	10/9	2/2	31/39

The practical view is clearer on 'identify and formulate a complex problem', while the abstract view is dominant on 'manage a complex problem in a critical and creative manner'. While supervisors might express the abstract 'identify' as "To define all complexities of the problem" or "To identify a complex problem means to look for the interdisciplinary parts of the problem", a practically, focussed MSc student articulation of 'formulate' is exemplified by "It means aim and subject" or "Define aim".

From the interpretation of criterion 4, related to formulating and managing a complex problem in an independent, critical, and creative manner, supervisors and students appear to have a common understanding even if the divide along the abstract vs. practical dimension remains. A student formulation might be "Break down into sub-tasks and consider how these interact with each other in order to comprise the overall solution" whereas a supervisor opts for the more abstract, or at least vague, "Choose proper methodology".

Although, 'identify' and 'formulate' obviously can be considered in practical terms, we note that both supervisors and students had struggled to express a specific and individual interpretation of these two dimensions of the criterion. These were the dimensions where reformulation was more frequent than an explanation. It is true that the supervisors' articulation of the criterion might be considered latent and integrally informed by a high level understanding of it that might be difficult to formulate or explain; however, this vague articulation remains problematic in terms of facilitating students' internalisation of standards.

Thus, the analysis of articulations for 'identify a complex problem' remains challenging. It appears to be understood in two ways by students as either "to make a plan" or as "to find a research space", while four of six supervisors simply reformulated the criterion. It might be that the dimension "identify" is closer to the discipline's givens and its methodology and therefore less pronounced than 'formulate' and 'manage', which are closer to the methods of a discipline.

Bachelor of engineering students' understanding and articulation of criteria 4 and 6

During the spring term 2012, all Bachelor of Engineering students at the division of structural engineering were offered a series of group activities to scaffold the thesis project process. Out of the14 students in total, 10 accepted and joined all the workshops. The group thus comprised 5 bachelor of engineering thesis projects with 2 students for each thesis. The groups acted as peer review groups for each other. They all did projects within structural engineering but had different research questions and worked on projects for different companies.

The workshop component that relates to student articulation of criteria interpretation is one where students self- and peer-assessed projects on late thesis versions approximately four weeks before deadline. Prior to the workshop, students where prompted to outline in their

own words dimensions of how their project and that of their peers met or failed to meet the criteria. The students where offered an empty matrix across the three levels of achievement for two phrases from the criteria ('independently manage problem formulation' and 'critically analyse and evaluate technical solutions') and were asked to place their projects in the grid (Table 4). [1]

*Table 4: Overview of Bachelor of engineering student articulation of criteria 4 and 6**

View (Self-/Peer-)	Independent	Formulate	Manage	Create	Critical evaluation	Analyse
Practical tasks listed	3/-	1/2	2/2	1/1	2/4	2/-
Tasks related to criterion	1/-	2/1	2/3	3/2	5/8	3/6
Echoing criterion	-/-	1/-	-/-	-/-	-/1	-/-

* Criterion 2 in the Swedish guidelines for BEng theses corresponds to MSc criteria 4 and 6.

A note on the coding of table 4 seems called for. We have attempted to divide the student phrases into statements and then code the statements according to the types of trends we isolated in our reading. We have not totalled statements since that information carries little if any value. Our first observation is that the coding reflects how there is a group of comments about projects, both their own and those of their peers, that are mere lists of activities or things with no explicit connection to the criteria phrases. Table 4 also suggests that the BEng students articulate a criterion-related phrase about the work of their peers for critical evaluation and analysis more often than about their own work. Such distribution might be indicative of its being easier to assess somebody else's work for these dimensions and that the students fail to see the corresponding elements in their own work. Perhaps unsurprisingly, the students' comments also appear to reveal that they can only assess 'independence' on their own projects. A final observation from table 4 is that the students' project-related assessment and the articulation of the level of achievement for criteria shows far fewer comments of a mere reformulating character as compared to the MSc students interpreting criterion 4 early on in their theses projects (Table 3).

What table 4 does not show very well is the character of the statements and how there is a qualitative difference between a statement like 'we look for solutions ourselves via the internet and literature' [our translation] for criterion 4 and 'very high quality' and a statement like 'evaluate the different existing surfaces and how they are affected by different load distributions' [our translation] for VHQ on a peer project. However, there are obviously difficulties assessing the understanding that goes into statements. One group assessed their peers with the remark that 'the delimitation to two stops might yield a good view of the problem but it might not be sufficiently holistic. There is a risk that you fail to observe damage in other places' [our translation]. This remark seems to reflect a high level of critical understanding of the impact of scope and delimitation relative validity and as such suggests significant understanding of the criterion. A statement like 'performed tests and developed an accessory clamping unit' [our translation] might seem like mere activities and hardly suggest and criterion-relevance but if the statement is unpacked it reveals significant detail and criterion understanding. Such in-depth understanding packed into a technical phrase is not surprising but to unpack it and access it we needed to conduct a follow-up interview with the specific student.

[1] Strictly speaking the criteria and rubrics are different for the Bachelor degree projects but for the consistency of this paper we have used the corresponding MSc criteria in tables 1 and 2.

Criterion-oriented supervision of structural engineering, design engineering and mechatronics engineering

During a yearlong conversation about degree project supervision and criterion-based assessment, three supervisors have continuously discussed and developed supervision practices. Between them they have supervised 10 structural engineering students in 5 projects; 8 design engineering students in 4 projects; 6 mechatronics students in 4 system control and mechatronics engineering projects. They all agree that the normal supervision practice would involve bi-weekly one-hour meetings with each project group with little or no focus on the process and general parts. While technically speaking the supervision and assessment is criterion-based, the supervision practice might simply involve directing students to the guidelines document. In fact, this kind of supervision practice was accentuated in the group as two of the mechatronics projects were deliberately supervised using bi-weekly meetings with little or no focus on the criteria and the other two used a more criterion-based supervision process based on the guidelines.

The quality assurance dimension of criteria would be vacuous unless students have experienced learning activities facilitating the required learning to meet the criteria. Hence, the main concern of the supervisors has been to turn the criteria-based assessment into a learning-oriented activity promoting thesis quality during the process. In an attempt to promote process awareness and concurrent criterion-orientation, the supervisors designed a series of activities where students were offered a chance to learn from each other. These activities are listed in Appendix 1 and briefly mentioned here. The primary objective of the approach was to cover the process as completely as possible, giving the students access to learning activities that would facilitate their work towards the learning outcomes of doing a degree project at Chalmers. However, from the descriptions of the activities, four of the criteria are emphasised: contribute to field of research; handle complex problems; implement advanced tasks within given framework; and create, analyse and evaluate technical solutions (Cf. criteria 3, 4, 5, and 6 in Appendix 1).

The exact setup varied between the three supervisors, but three workshop activities recur in their practice. The first activity was directed towards objectives, vision, risks, and aimed at generating a brief project action plan. After the activity the students were to write their planning reports including preliminary ideas for suitable methods and theories. If the planning report activity also prompts to the students to define the success of the project, as a measureable component, then they have a very tangible way of assessing their progress in the project. Project plans tended to require rewriting for purpose and vision and for some projects (in design engineering) they were revised iteratively (especially the milestones) during the entire thesis process. Not surprisingly, the supervisors find that the students appreciate this activity as it gives them a good idea of the progress of their project and an awareness of whether or not will be able to reach their goals.

The second activity focused on the identification of a research space by a review of a selection of their references. It tended to be placed a couple of weeks into the project and offered an opportunity to discuss relevant literature from the start. The supervisors noted how they needed to be quite explicit about the need for additional and continuous literature review during the entire project to find complementary, relevant literature for subsequent issues in their projects. Some students tended to believe that this activity was all the literature review they were expected to do. A notable version of the activity is to ask peer groups at the workshop to present their peers' references in order to initiate the subsequent peer response work.

The third activity focused on the analysis of results and how this can be managed. In this activity, the criteria were copied into the workshop material and students performed both self- and peer assessment on their work relative the criteria by 'inserting' their own and their peers' project in the matrix. With an explicit reference to and discussion of criteria 4, 5, and 6, the activity helps promote students' sense of ownership and quality in their projects. As the supervisors pursued the workshop discussions, they also observed the students' reflections on the criteria and how the students gained a more informed understanding of criteria and quality than previous degree project students had. So, significant quality and understanding of the criteria was facilitated simply by letting the students reflect for themselves on all the criteria and write comments on how, and to what extent, they would reach the criteria from the matrix.

From a student perspective, many of the criteria are intertwined, which is also something we have observed in the supervisor conversation. Another aspect of the criteria that has been pronounced in the conversation is that depending on department or discipline, some criteria are more or less by default fulfilled. For example in mechatronics engineering projects, criterion 7, which concerns system integration, is almost met by default since almost every master's thesis in the area of signals and systems is related to system function development or complete system integration and development.

Discussion and lessons learned

Despite the limited data collection and the limited scope of the current pilot study, we still believe that some closing observations can be made. While the two questions we ask ourselves are still a long way from conclusive answers, they appear relevant from the point of view of the design of the current evaluation practices for the external audit from the Swedish National Agency for Higher Education. Hence some tentative discussions points are called for as our initial efforts might generate similar discussions in other Swedish universities.

How do supervisors and students, respectively, understand, integrate and act on university-wide criteria for theses such as the ones distributed at Chalmers since 2008?

First of all, we see from the 12 supervisors' articulation of criterion interpretation that there is risk that their supervision practice is guided by completely internalised standards to the point that they have difficulties re-phrasing the criteria for students. From the 13 MSc students we see criterion articulation that suggests they have a vague understanding at best and that they sometimes end up merely echoing the phrases of the criteria when asked to explain them. We also observe from the data that the BEng students benefited from assessing technical aspects of their projects as a way of assessing their criteria achievement at the privileged point of being within a month of the deadline for the projects. Where the MSc students expressed practical yet vague articulations of criteria interpretation early on in projects, the BEng students linked criteria fulfilment to more specific practical and criterion-related phrases. However, there is a potential confounding factor in that BEng students have encountered their supervisors in previous course contexts and may even have seen criteria that they use for specific course-based assignments. Thus they might be somewhat more familiar with the programme's standard than incoming international MSc students would be. The BEng students and their peer review also shows us that it allowed students and opportunity to observe criteria fulfilment that strikes us as rare in assessment contexts.

Our second observation on this yearlong process is that even with a small group of supervisors, a shared understanding of criteria is a tall order. The difficulties lie in the complexity of articulating criteria in the first place and the literature appears to prepare us for that. What is also apparent is that the deeper, latent difficulty in criterion-based supervision is the range of departmental disciplinary cultures at the university and the way in which they turn aspects of quality into givens.

Our conversation has also shown that supervisors and students have no way of integrating and acting on the criteria until they have been activated as parameters in the supervision process. The supervisor group unanimously found that simply adding the criteria in the summative assessment stage had had no or only minor effect. The group also found that the 'traditional' bi-weekly set up and draft reading towards the end tended to make criteria and the disciplinary standards implicit or hidden.

What can supervisors and students do to enhance thesis quality through criterion-based supervision and revision?

It is possible that answering this question is the most tentative dimension in our study so far. However, our lessons learned suggest that we do see how rubric-articulated supervision can serve as an important balancing factor to mere in-text commentary and bi-weekly meetings. Based on the supervisor observations and the ongoing conversation also suggest that one important aspect of such supervision design is that it seems to increase self-efficacy among students (Bandura, 1977, 1995).

Another point that needs making is that the rubric does not seem to have had the effect of reducing student autonomy as Torrence (2007) and Bailey (2009) warn against. The critical component, we believe, is that the suggested activities avoid the standardised rubrics Torrance and Bailey discuss, respectively. Instead, the criterion-based rubric-articulated supervision in our study is one where the rubric is a student-negotiated one specific to each student project. Therefore, a supervisor revelation was the observation that the students changed their language during the period. This shows that they understand the different components of their projects. An example would be the student comment that "[i]n this sub-process we get data that shows this, but we lack another sub-process that underline and prove that the result is correct". Another indication of quality enhancement is the increased student interest and engagement. According to them, this was due to understanding why they do certain things and that the process could be seen as building blocks. Or, in other words, that they were developing an awareness of the process of conducting a thesis project.

Our third point would be that the structured activities generate a continuous feedback environment and hence provide multiple opportunities for oral and written feedback early on in the projects. Not surprisingly, this emphasis on early (oral) feedback is in line with research by e.g., Rae and Cochrane (2008), listing dialogue as one of the key components leading to student understanding of criteria and feedback, and is an activity that students request but rarely feel that they get. In this sense, the early oral feedback enhances the self-efficacy component of this design. In fact, Nicol and Macfarlane-Dick (2006) propose dialogue as the way forward student-centred assessment/feedback practices where students engage in self-regulated learning, and this perspective is elaborated in Nicol (2010) as well as in Cramp (2011). Such a feedback strategy appears to help promote the community approach that O'Donovan, Price, and Rust (2008) suggest is crucial for understanding standards.

Also, the rubric necessarily gives equal weight to positive and negative aspects, and is therefore more likely to give a more balanced picture than in-text comments without any clear connection to criteria, which research has shown tend to focus on negative aspects of

student work (Weaver 2006). Rubric-articulated supervision allows for an achievement-oriented function of indicating which level of learning has been reached, whereas in-text supervision without references to criteria or rubrics often has the function of emphasising the mistakes that have been made. This balancing aspect of rubric-articulated feedback is particularly apparent in the 10 BEng students self- and peer assessment. Even at a quick superficial glance at the rubric, a student sees that it outlines more strengths and criteria achievement rather than mistakes. This is a rare event in most higher education feedback and well-worth pursuing further.

But there are problems too of course. The fact that our supervision strategy seemed novel to students is a major obstacle to maximizing impact. In other words, the programme supervision alignment is insufficient. If there had been a larger number of supervision situations previously in the respective programmes that employed similar activities and techniques, the degree thesis students are likely to benefit even more and probably with less of an investment in time. Such alignment efforts may help address what appears to be a limited ability to articulate criteria understanding as the students and the supervisors in this pilot study may have simply lacked the language to talk about the criteria.

Thus, the relative novelty of the activities might in itself be demanding and in the challenge they posed generate counter-productive hesitation and uncertainty. As suggested by e.g., Hounsell et al. (2008) such negative feelings may decrease proportionally with students' familiarity with the learning activity if a culture of self-assessment is introduced in a course, or in a sequence of courses (for a recent discussion of self-assessment, see Leach 2012). In our case, a culture of criterion-based rubric-articulated supervision might present such a culture and offer an avenue towards creating sound formative assessment strategies that are student-centred.

We hope to have shed some light on the difficulty of interpreting criteria and articulating an understanding of criteria relative a specific project. We also suggest that rubric-articulated criteria-based assessment can be promoted through a more active and collective supervision process. At the same time we know that further research is needed on how to successfully incorporate scaffolding learning and assessment activities into thesis supervision design with the goal of maximizing student learning and student ownership through optimal understanding of the purpose of learning activities and criteria.

References

Adawi, T., Gustafsson, M., Saalman, E., Stehlik, T. & Thew, N. (2011). "A university wide action research project to enhance teaching and learning through constructive alignment". Paper presented at the SUHF conference, Stockholm, November 14-15.

Bailey, R. (2009). Undergraduate students' perceptions of the role and utility of written assessment feedback. *Journal of Learning Development in Higher Education, 1*. [Online]. Available from: http://www.aldinhe.ac.uk

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191-215.

Bandura, A. (1995). *Self-efficacy in changing societies.* Cambridge, New York, NY, Melbourne: Cambridge University Press.

Biggs, J. & Tang, C. (2007). Teaching for quality learning at university: What the student does, 3rd ed. McGrawHill, Maidenhead & New York, NY: SRHE & Open University.

Boud, D. (2012, October). Assessment as equipping students for future challenges. *NU2012 – Gränslöst lärande October 17-19*. Keynote from SUHF, Göteborg University, Chalmers University of Technoology, Högskolan i Borås, Högskolan Halmstad, Högskolan Jönköping. Göteborg

Boud, D. and Falchikov, N. (2006). Aligning assessment with long-term learning. *Assessment & Evaluation in Higher Education, 31* (4), 399-413. doi: 10.1080/02602930600679050

Chalmers University of Technology. (2011). Guidelines for assessing the quality of degree projects under Chalmers' Civilingenjör, Master of Architecture & Master of Science Programmes Available from https://student.portal.chalmers.se/en/chalmersstudies/masters-thesis/Documents/Exjobb_bed%C3%B6mning_kriterier_20110517_EN (2).pdf

--- (2011). Riktlinjer för bedömning av kvalitet på examensarbete vid Chalmers högskoleingenjörsprogram Available from https://student.portal.chalmers.se/sv/chalmersstudier/kandidat-och-examensarbete/examensarbete/Documents/Riktlinjer_bedomning_kvalitet_exjobb_hing.pdf

Cramp, A. (2011). Developing first-year engagement with written feedback. *Active Learning in Higher Education, 12,* 113-124, doi:10.1177/1469787411402484

Crisp, G. T. (2012). Integrative assessment: reframing assessment practice for current and future learning. *Assessment & Evaluation in Higher Education*, *37* (1), 33-43. doi: 10.1080/02602938.2010.494234

Crossouard, B. (2010). Reforms to higher education assessment reporting: opportunities and challenges. *Teaching in Higher Education, 15* (3), 247-258. doi:10.1080/13562511003740809

Denzin, N. (2009). *The Research Act.* New Brunswick-London: Aldine Transaction

Hounsell, D., V. MacCune, J. Hounsell, & J. Litjens. (2008). The quality of guidance and feedback to students. *Higher Education Research & Development,* 27 (1), 55-67. doi: 10.1080/07294360701658765

Hyland, A., D. Kennedy and N. Ryan. (2006). Writing and using learning outcomes: a practical guide. In *EUA Bologna Handbook. Making Bologna Work,* ed. E. Froment, J. Kohler, L. Purser, L. Wilson, H. Davies & G. Schurings, C3.41, 1-30. Berlin: Dr Josef Raabe Verlag.

Kember, D. (2000). *Action learning and action research: Improving the quality of teaching and learning.* London & New York: Routledge.

Leach, L. (2012). Optional self-assessment: some tensions and dilemmas. *Assessment & Evaluation in Higher Education, 37* (3), 137-147. doi: 10.1080/02602938.2010.515013

Malmqvist, J. Wedel, M & Enelund, M. (2011). Constructive alignment (CA) for degree projects – Intended learning outcomes, teaching & assessment. Proceedings of the 7th International CDIO Conference, Technical University of Denmark, Copenhagen, June 20 - 23, 2011

Nicol, D. and D. Macfarlane-Dick. (2006). Formative assessment and self-regulated learning: a model and seven principles of good feedback practice. *Studies in Higher Education, 31* (2), 199-218. doi: 10.1080/03075070600572090

Nicol, D. (2010). From monologue to dialogue: improving written feedback processes in mass higher education. *Assessment & Evaluation in Higher Education 35* (5), 501-517. doi: 10.1080/02602931003786559

Norton, L.S. (2009). *Action research in teaching and learning. A practical guide to conducting pedagogical research in universities.* London & New York, NY: Routledge.

O'Donovan, B., M. Price and C. Rust. (2008). Developing student understanding of assessment standards: a nested hierarchy of approaches. *Teaching in Higher Education 13* (2), 205-217. doi: 10.1080/13562510801923344

Rae, A.M. and D.K. Cochrane. (2008). Listening to students – How to make written assessment feedback useful. *Active Learning in Higher Education, 9* (3), 217-230. doi: 10.1177/1469787408095847

Reddy, Y. M. and Andrade, H. (2010). A review of rubric use in higher education. *Assessment & Evaluation in Higher Education, 35* (4), 435-448. doi: 10.1080/02602930902862859

Riel, M. (2010). Understanding action research, Center For Collaborative Action Research. Pepperdine University. http://cadres.pepperdine.edu/ccar/define.html.

Rust, C., M. Price and B. B. O'Donovan. (2003). Improving students' learning by developing their understanding of assessment criteria and processes. *Assessment & Evaluation in Higher Education, 28* (2), 147-164. doi: 10.1080/0260293032000045509

Sadler, R.D. (2005). Interpretations of criteria-based assessment and grading in higher education. *Assessment & Evaluation, 30* (2), 175-194. doi: 10.1080/0260293042000264262

Torrance, H. (2007). Assessment *as* learning? How the use of explicit learning objectives, assessment criteria and feedback in post-secondary education and training can come to dominate learning. *Assessment in Education, 14* (3), 281-294. doi: 10.1080/09695940701591867

Weaver, M. (2006). Do students value feedback? Student perceptions of tutors' written responses. *Assessment & Evaluation in Higher Education, 31* (3), 379-394. doi: 10.1080/02602930500353061

Yorke, M. (2003). Formative assessment in higher education: Moves towards theory and the enhancement of pedagogic practice. *Higher Education, 45*, 477-501.

Appendix 1:

Table 1: Abbreviated version of the guidelines with supervisors' learning activities added

Rubric	MSc learning outcome criteria	Learning activity
	1. Significant specialised knowledge within the main field of study/focus of the study programme including specialised insight into relevant research and development work	Literature review peer workshop; Self-articulated rubrics
VHQ	Significant specialisation within the main field of study is demonstrated. The project utilises knowledge from studies on an advanced level within the main field of study. A comprehensive review of existing literature has been performed and there is reflection on the project's connection to the existing knowledge in the main field of study. The project contributes new knowledge in the main field of study and clearly presents it. The project demonstrates an ability to independently contribute to the field of study.	
HQ	Significant specialisation within the main field of study is demonstrated. The project utilises knowledge from studies on an advanced level within the main field of study. A comprehensive written review of existing literature has been performed and there is reflection on the project's connection to the existing knowledge in the main field of study.	
IQ	The project's connection to the main field of study is weak or non-existent. Knowledge from an advanced level within the main field of study is not utilised. A literature review and reflection on the project's connection to related areas of knowledge are missing.	
	2. Specialised knowledge of methods within the main field of study of the study programme	Objectives, risks and visions workshop; Literature review peer workshop; Results analysis workshop; Self-articulated rubrics
VHQ	Potentially relevant engineering or scientific theories and methods have been identified. The selection of theory and method is well justified. Selected theories and methods have been applied in a correct and innovative manner. The project demonstrates an in-depth and broad knowledge of methods.	
HQ	Potentially relevant engineering or scientific theories and methods have been identified. The selection of theory and method is well justified. The selected methods have been applied in a correct manner.	
IQ	The project's selected theories and methods lack relevance. The student has not demonstrated mastery of the selected theories and methods.	
	3. Ability to contribute to research and development work	
VHQ	--*	
HQ	The contribution to research or development work is clearly presented.	
IQ	The project's character makes it difficult to connect the project to research and development work.	

	4. Ability to identify, formulate and manage complex problems in a critical, independent and creative manner from an overall perspective	Objectives, risks and visions workshop; Self-articulated rubrics
VHQ	The project has a clear and delimited problem or formulation of objectives. The problem/formulation of objectives has been studied in an adequate, critical and reflective manner. There is a clear connection between the problem/formulation of objectives, results, discussion and conclusions. The project's conclusions are well supported and correct.	
HQ	The project has a clear and delimited formulation of the problem. The problem has been studied in an adequate manner. There is a clear connection between the problem, results and conclusions. The project's conclusions are well supported and correct.	
IQ	The project does not have a clear problem or formulation of objectives or this is lacking altogether. Irrelevant method(s) used. The project does not present an answer to the problem or a result that is related to the objective. Conclusions are incorrect.	
	5. Ability to plan and use adequate methods to implement advanced tasks within given frameworks, as well as evaluate these efforts	Objectives, risks and visions workshop;
VHQ	-- *	
HQ	A realistic plan for the project was formulated. The set times that were communicated and established have been adhered to when performing the project. Necessary modifications for implementation have been documented and communicated.	
	6. Ability to create, analyse and critically evaluate different technical/architectural solutions	Results analysis workshop; Self-articulated rubrics
VHQ	The project produces new solutions that are analysed and evaluated in a critical manner. Alternative solutions have been produced and treated in a relevant and exhaustive manner.	
HQ	The project produces solutions that are analysed and evaluated in a critical manner.	
IQ	The project has not documented or presented as indicated above in a clear manner. [sic]	
	7. Ability to integrate knowledge in a critical and systematic manner	Literature review peer workshop; Self-articulated rubrics
VHQ	The project innovatively integrates knowledge and methods from several subjects.	
HQ	Relevant knowledge and methods have been obtained and applied.	
IQ	Areas that are relevant to the project are not addressed or are not used. Selected and obtained knowledge is not presented in a clear manner and is not justified.	

*: Not all the criteria in the guidelines have a rubrics phrase for 'very high quality'