METHODICAL EVALUATION OF SINGLE AND GROUP PROJECTS

Josef Ponn, Matthias Kreimeyer, Udo Lindemann
Institute for Product Development, Technische Universitaet Muenchen, Germany

ABSTRACT
Evaluation and grading of student projects is a difficult undertaking. It has to be fair towards the student, recognize his work and evaluate his success, but also motivate him for his future learning. At the same time, a project has to be judged justly in comparison to the overall student body and the general level of quality that is to be expected. Ultimately, individual supervision of these projects, as commonly exercised in the German university system, creates personal bonds that, however, must not influence the final grade. The challenge is even higher when assessing student projects where students work together as a team and collaborate on a common topic.
This paper proposes a methodical evaluation based on a number of criteria that have been designed to enable an overall evaluation of a student's work. To ensure overall fairness and the workflow, a standardized template is used. The criteria are communicated to the students before the start of any individual project.
Frequent use over the past two years has shown that the system in place works well. It helps supervisors overcome individual (dis)likings and judge the overall project according to the institute's general quality standards and, at the same time, raises transparency among the students as to the expectations to their work. For this reason, this paper is also meant to be an example of a best practise in design education.

Keywords: evaluation, grading, student term project, group work, seminar

1 DESIGN PROJECTS IN UNIVERSITY EDUCATION

The aim of design education is to endow students with **competencies** for their professional life. Concerning the spectrum of competencies, Eder & Hubka distinguish following categories: heuristic/practice-related, branch/subject-related, methods-related, systems-related, personal/social as well as socio-economic competencies [1]. Albers et al. describe five competency fields that are of equal importance in today's working environment: professional competency, social competency, teamwork, methodical competency, creativity and elaboration potential [2]. Globally, a large variety of competencies has to be provided to the prospective engineer during his studies at university. The corresponding methods applied to teach these competencies are various. Lectures and tutorials serve for communicating a solid theoretical foundation.
To provide opportunities for gaining practical experience and mediate professional competency, **student design projects** are a common means of teaching. At the Technische Universitaet Muenchen, students have to finish three projects of different scope throughout the curriculum. While the two term projects ("Semesterarbeiten") typically amount to about four months of full time work, the Master Thesis at the end of the curriculum is designed as a project of six months full time work. Students usually

receive a task description and some initial work material when starting their projects and are closely supervised throughout their work. For each project, they have to hand in a written report. The final grade has to be countersigned by two supervisors to ensure fair treatment of the student. The projects take different forms but are always of scientific character. They can range from classic design tasks, e.g. the development of a certain device ("constructive"), to researching the means of managing communication in the design process ("theoretical"), to running a series of tests or trials ("experimental"). Often, the term projects are part of larger research projects that are funded publicly or are executed in cooperation with industry. The projects can therefore take many shapes.

2 ASSESSMENT OF STUDENT DESIGN PROJECTS

2.1 General aspects and challenges of student assessment

Williams & Gajendran stress that "Assessment of students is a fundamental and pervasive element of teaching and learning, and a potentially powerful means of driving their continuous improvement" [3]. This paper concentrates on summative assessment at the end of a student project (as opposed to formative assessment throughout the course of the project). In the following, various important aspects are being discussed.

Performance: Grading is one of the primary outcomes of an assessment. Grades indicate whether and how well a particular student has attained the formulated requirements of the project task, relating to both the actual results and their documentation. Since student design projects usually incorporate a high degree of teamwork and project results are developed together, the individual performance has to be distinguished from the overall team performance.

Motivation: An assessment has to motivate the student for future learning. The positive aspects need to be stressed in order to recognize the student's work. In addition, the negative aspects also have to be clarified in order to show potential for optimization in further projects. Criticism is necessary, but it has to be provided in a constructive way.

Fairness: Assessment has to be fair with respect to the overall student body and the general level of quality that is to be expected. This task is challenging because of the fact that different students are assessed by different supervisors on different projects. Therefore, the assessment method and process has to assure the most possible objectivity and transparency. Another aspect in this regard is that the final grade must not be influenced by personal bonds created during the course of the project.

Feasibility: Finally, the assessment process has to be as uncomplicated as possible, which is a matter of the right workflow and template.

2.2 Methodical assessment

There are a number of approaches available for the assessment of student projects and collaborative learning. Most educational institutions have edited guidelines (e.g. http://www.cshe.unimelb.edu.au/assessinglearning) based on scientific insights. However, these have to be adapted to the specific context of how projects are integrated into the curriculum. The approach that is presented in the following therefore is specifically adapted to the German term projects that can take a wide variety of shapes, while it provides objective grades to ensure fair and comparable grading across several projects and supervisors.

According to the **Munich Method Model** [4], four different aspects have to be regarded when designing methodical support for a task: the description of the setting the method

is applied in, the selection of criteria that determine what kind of method is used, the adaptation of the method and, ultimately, the application of the method.
Methodical support therefore has to provide understanding of the setting, i.e. what kind of project is to be evaluated and what criteria may be relevant to this project and the overall goals of engineering design education. Secondly, it has to deliver an overview of in- and outputs as well as other aspects to select the right set of evaluation criteria when grading the project. These have to be adapted for different kinds of projects, e.g. when assessing team projects or the work of a single student. Ultimately, tool support that enables the efficient application has to be available.
Each project is analyzed individually for the fulfilment of a set of **evaluation criteria** as listed in Figure 1. These are communicated to the student when his project is started to provide transparency of the expectations set on the work and to clarify the expectations set out. Three groups of criteria are relevant: How the project is carried out, the quality of the documentation and the quality of the final presentation (if applicable). This way, the overall project is scored to ensure that e.g. bad projects that are well written up and well presented are graded accordingly. The equal weights of the grading for how the project is carried out and how it is documented try to balance the need for the fact that especially for theoretical projects the results and the documentation often coincide.

How the project is carried out	
Clarification of task	Problem analysis, information search
Determination of solutions	Creativity, methodical approach
Results	Quality, scope and quantity, use of scientific "state of the art"
Reflection	Critical consideration of proceeding, methodical approach and of results, conclusions
Work style	Way of working during project work and authoring of documentation (target-orientation, independence, initiative, teamwork, commitment, reliability)
Efficiency	Time spent for project, time spent for authoring of documentation
How the project is documented	
Preface	Is the reader introduced to the topic properly? Is the reader guided well? Is the initial situation, i.e. the motivation of project, made obvious? Is the task formulation concerning the objective of the paper obvious? Is an overview (chapters, structure) of the paper given? Is content of the paper apparent by means of the preface?
Summary	Is content of the report made clear? Is an outlook on actual or potential future activities given? Is the bottom line of the project articulated understandably?
Technical writing	Is the narrative style (formulations, etc.) appropriate for a report? Are the spelling and grammar of the descriptions correct? Are formal rules being adhered to (format and layout, marking of images, citations, bibliography, etc.)? Is the layout attractive and clear? Are the graphics useful, concise and comprehensible?
Structure	Are the chapters designed in a consistent way? Is the content presented in a useful order? It there a thread to be followed throughout the document?
Contents	Is the coverage of the paper appropriate? Are the contents made clear? To what level of detail are the contents described? Are the performed activities completely documented in the project?
Methodical approach	Is the method description (i.e. the theory behind the problem and methods)… …appropriate? …comprehensible? …at the right quantity? …only Copy-Paste from the lecture notes and publications? Is the use of methods made tangible using examples from the project's context? Is the use of methods being questioned critically (reflexion)?
How the project is presented (oral presentation, only applicable for Master Thesis)	
Content	Is the content of the presentation appropriate?
Style	Is the style of delivery appropriate? Is the quality of slides appropriate? Is the time limit (20 minutes) observed?

Figure 1: Overview over evaluation criteria (checklist)

In a **formal procedure**, the student's overall score is calculated. For each new project, all 14 criteria shown in Figure 1 have to be evaluated. Each criterion (e.g. "content of the presentation") is graded individually on a scale also used in the university's reports, which therefore responds to the common understanding. However, not all criteria are equally weighted, depending on the type of project. For example in a literature study little creativity is required, while the design of a new stove that runs on plant oil necessitates the application of a wide array of creativity methods. Thus, a general distribution of weights for each factor is used (see column three in Figure 2) that can be adapted to some extent when necessary to reflect the kind of project. This way, an overall score is generated that can be rounded to fit the actual increments provided by the official grading scheme of the university (1.0, 1.3, 1.7, 2.0,…). Figure 2 shows an example of this procedure.

Criteria	Weighting absolute	Weighting in Percent	Inadequate	Adequate	Satisfactory	Good	Very Good	Points Score	Points Score x Weighting
Project	**45**	**45%**							
Description of task	9	9%				x		3	27
Det. of solutions	9	9%			x			2	18
Results	9	9%		x				1	9
Reflexion	6	6%				x		3	18
Way of working	6	6%					x	4	24
Efficiency	6	6%				x		3	18
Documentation	**45**	**45%**							
Preface	3	3%			x			2	6
Summary	3	3%				x		3	9
Form	9	9%			x			2	18
Structure	6	6%					x	4	24
Contents	18	18%				x		3	54
Methodical approach	6	6%			x			2	12
Presentation	**10**	**10%**							
Content of presentation	5	5%						0	0
Style of Delivery	5	5%						0	0
Sum	**100**	**100%**						**Reached Score**	**237**
								Calculated Grade	**2,63**
								Calculated Grade (rounded)	**2,7**

Rounding Rules

1,00 - 1,15 = 1,0
1,16 - 1,50 = 1,3
1,51 - 1,85 = 1,7
1,86 - 2,15 = 2,0
2,16 - 2,50 = 2,3
2,51 - 2,85 = 2,7
2,86 - 3,15 = 3,0
3,16 - 3,50 = 3,3
3,51 - 3,85 = 3,7
3,86 - 4,15 = 4,0
4,16 - 4,50 = 4,3
4,51 - 4,85 = 4,7
4,86 - 5,00 = 5,0

Figure 2: Weighted evaluation criteria and rounding of final grade (per supervisor)

2.3 Assessment of single projects and theses

These aspects are integrated into an **assessment workflow** that is part of the administrative procedure to grade a student. Before both supervisors sign the actual report of the project, they first have to work their way through an evaluation form shown in Figure 3. Each supervisor completes a checklist to provide short text-based descriptions of how the formal criteria were met in the project (the two pages on the right hand side of Figure 3). This way, the supervisor is obliged to reflect upon each criterion equally to make the grading more complete. The checklist requires the supervisor to complete each aspect given in the list in figure 1 with a short description.
Secondly, these descriptions are graded in a scheme comparable to the overall university grading scheme, specifying whether the criterion is met in a way that is "inadequate" (5), "adequate" (4), "satisfactory" (3), "good" (2) or "very good" (1). Again, all aspects as lined out in figure 1 are to be graded.
Thirdly, the weights can be adjusted if necessary. Typically, this is only the case if a supervisor is unable to assess a part of the project (e.g. when part of the project was

only supervised by one person). Often, students can be motivated to present their results orally to progress their presentation skills and improve their grade by including the presentation into their overall project score.
When grading an actual project, a **standardized template** is used into which two spreadsheets as seen in Figure 2 are embedded (see Figure 3 for an example). This document also serves for later information requests of the student, e.g. when the fairness of the grading is questioned or the decision has to be re-assessed.

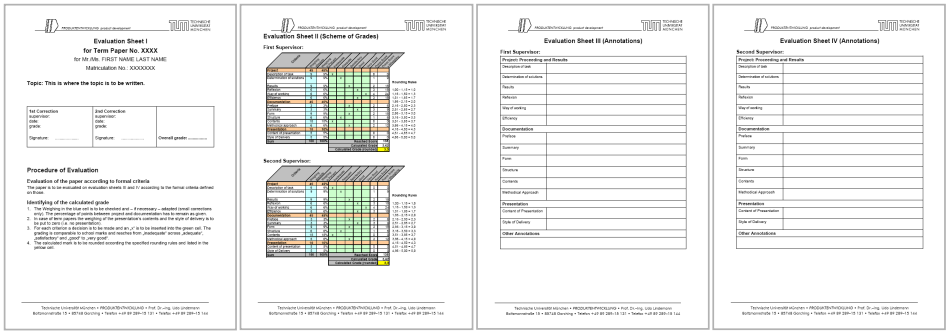

Figure 3: Check sheets used for evaluation of students' projects

2.4 Assessment of team projects

While experience with the actual grading procedure has been excellent, it has proven difficult to deploy for seminars or group projects like product development seminars (see e.g. [5]). In such cases, students generate the actual project results together as a team. However, their individual contributions have to be assessed for both adherence to formal rules of the university and for reasons of a fair and equal treatment of the participants to avoid that single students have their work done for them by the rest of the group. Therefore, the upper ("project") part of the grading scheme (as seen in Figure 2) was extended to enable the comparative assessment of any number of students in a project (realistically four to seven). Figure 4 shows the global layout for three students (i.e. six columns, as two supervisors are necessary each time). On the left, the project evaluation criteria are given and detailed. Equally, the weights are represented. Again, an overall score for the project is calculated that is transferred to the individual assessment forms to provide individual final grades for the project.

			project													
		name of student	NN1				NN2				NN 3					
		supervisor	1.		2.		1.		2.		1.		2.			
Proceeding and Results			comment	grades	comment	grades	comment	grades	comment	grades	comment	grades	comment	grades		
Kriterium	Aspekte			inadequate adequate satisfactory good very good		inadequate adequate satisfactory good very good		inadequate adequate satisfactory good very good		inadequate adequate satisfactory good very good		inadequate adequate satisfactory good very good		inadequate adequate satisfactory good very good		
Description of task	- problem analysis - information search	9%		x		x		x		x		x		x		x
Determination of solutions	- creativity - methodical approach	9%		x		x		x		x		x		x		x
Results	- quality - scope and quantity	9%		x		x		x		x		x		x		x
Reflexion	- critical consideration of - critical consideration of methodical approach - critical consideration of results - conclusions drawn	6%		x		x		x		x		x		x		x
Work style	- way of working during project work and authoring of documentation o target-orientation o independence, initative o teamwork o commitment o reliability	6%		x		x		x		x		x		x		x
Efficiency	- time spent for project - time spent for authoring of documentation	6%		x		x		x		x		x		x		x

Figure 4: Comparative evaluation of three students within one project

3 SUMMARY AND REFLECTION

This work presents a methodical approach to provide a means of grading both individual and team design projects. The scheme is designed to evaluate the student's performance, to help him be motivated, to provide overall fairness and to be easily executed. It therefore consists of a number of criteria representing the necessary competencies to be conveyed by modern university education, a grading scheme adaptable to the actual project's context and a formalized procedure to actually effect the grading.

The presented approach has been in place for almost three years at the time of writing, having enabled teachers and supervisors to quickly adapt to the standards set at the institute. As especially PhD students remain in office only for a limited time, this has proven very valuable to compensate for the fluctuation of experience in grading and the inherent inadequacies otherwise inevitable. Also, it has been an extremely useful documentation when students were not satisfied with the outcome of their projects. In such cases, the transparency generated by communicating the evaluation criteria at the beginning of the project has yielded good impact. The template is easily applicable, making the rather subjective assessment more objective and comparable. It therefore is well able to judge a student's performance efficiently. As from a student's point of view, the approach is perceived both fair and motivating, especially as in such a way personal barriers that often impact a more 'subjective' evaluation are taken away. Furthermore, different levels of commitment are rewarded as well as different kinds of results. Ultimately, students appreciate the knowledge of what expectations they have to live up to, which, again, proves to be most motivating.

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Matthias KREIMEYER
Technische Universitaet Muenchen
Institute for Product Development
Boltzmannstrasse 15
D-85748 Garching
Germany
matthias.kreimeyer@pe.mw.tum.de
+49 89 28915136