# Assessment of Students Projects – Numbers, Letters, Words?

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## Abstract

The evaluation and assessment of engineering programmes is a big issue, and there exist many concepts and methods. This paper deals with *the assessment methods which can be used when assessing the knowledge, skills and competences developed in projects using PBL (problem based and project organized learning) pedagogical approaches. The experience of assessing first year projects from the Medialogy education at Aalborg University and third year projects from the Electrical and Computer Engineering Department at University of Minnesota, Duluth are presented, and the different methods discussed. The conclusion is that process as well as product has to be assessed in a way which evaluates all aspects of students’ learning outcomes.*

## Keywords: Assessment, PBL, project work, Medialogy, electrical engineering.

## 1. Introduction

New engineering programmes are being developed to meet the requirements of society and industry. Specific knowledge, skills and attitudes are needed if industry is to stay innovative and competitive in a global world. As a consequence, while engineering education has been innovating in the area of emerging disciplinary and interdisciplinary knowledge, research and technologies, as well as in new pedagogical approaches to meet the needs, it is still lacking useful assessment and evaluation methods [1]. The evaluation of engineering programmes has been on the agenda for several decades, and the amount of literature dealing with different evaluation approaches shows that there are many useful concepts and methods [2]. The problem we have experienced is the lack of assessment methods which can be used when assessing the knowledge, skills and competences developed in projects using PBL (problem based and project organized learning) pedagogical approaches [3]. These projects are very complex to assess because each project is unique. This is a huge challenge that involves many resources for the teachers who are going to assess the projects, because the content of the different projects often requires different assessment criteria, which still have to be consistent with the learning goal of the official study regulation or learning module. A number of different assessment methods are available for project work which can be used for the assessment of a range of different skills, and for its evaluation, either formative or summative, by different assessors. These assessment approaches take account of different outcomes of the learning: technical knowledge, problem-solving, communication, teamwork, independent learning, and so on [4]. It is important for the teachers assessing the projects to have the necessary tools for assessment.

In this paper we will introduce the Danish and American grading scale, and then present the experience from two cases: the assessment of first year projects from the Medialogy education course, Aalborg University (AAU) [5], and third year projects from the Electrical and Computer Engineering Department at University of Minnesota Duluth (UMD) [6] The assessment methods used in the two cases are discussed. Furthermore students’ expectations and teachers’ experience of the methods used for assessing the projects are presented.

**2. The grading scales**

In the academic year 2005–6 Denmark introduced a new scale, *7-trins-skalaen* (7-step-scale; colloquially dubbed the 12-scale), designed to be compatible with the ECTS grading scale. The Ministry of Education also wanted to adopt a more international way of grading, by allocation a set number of grades because in foreign countries, the grade A (12) is handed out twice as often as it is handed out in Denmark [6]. The scales are set out in Table 1.

Table 1: The Danish, the ECTS and the American grading scale [7]

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Definition** | **Excellent** | **Very Good** | **Good** | **Satisfactory** | **Passed** | **Failed** |
| **7-point scale** | 12 | 12 | 10 | 7 | 7 | 4 | 02 | 00 | 00 | −3 |
| **ECTS scale** | A | A | B | C | C | D | E | FX | FX | F |
| **American scale (4.0)** | A+ | A− | B+ | B | B− | C+ | C | F | F | F |
| **American scale (4.3)** | A+ | A | A− | B+ | B | B− | C | F | F | F |
| **American scale (4.5)** | A+ | A+ | A | B+ | B+ | B | C+ | F | F | F |

The definitions of the respective grades are as follows:

Grade 12 (A, A−) should be awarded for an excellent performance displaying a high level of command of all aspects of the relevant material, with no or only a few minor weaknesses.

Grade 10 (B+, B−) should be awarded for a very good performance displaying a high level of command of most aspects of the relevant material, with only minor weaknesses.

Grade 7 (B, B−) should be awarded for a good performance displaying good command of the relevant material, but also some weaknesses.

Grade 4 (C+, C−) should be awarded for a fair performance displaying some command of the relevant material, but also some major weaknesses.

Grade 02 (C–, C+) should be awarded for a performance meeting only the minimum requirements for acceptance.

Grade 00 (F) should be awarded for a performance which does not meet the minimum requirements for acceptance.

Grade –3 (F) should be awarded for a performance which is unacceptable in all respects.

The grading scale is clear, and it is possible for students to compare their results in an international environment, but giving students useful feedback on their projects is difficult. Then the performance against the official goals has to be used as the basis for providing feed-back.

**3. Grading student projects**

***Case: Medialogy first year, AAU***

Aalborg University’s engineering and science programmes are structured in modules and organized as PBL studies. A module is a programme element which aims to give the students a set of professional skills within a fixed timeframe specified in ECTS credits, and concluding with one or more examinations within a specific exam period. The programme consists of lectures, classroom instruction, project work, workshops, exercises, and so on. In Table 2 the different modules of the Medialogy programme are shown.

Each semester has a theme which provides the framework for a student’s semester project. Students form a project group of five to seven persons, and this group has to complete the project according to the goals set out in the study regulation. All modules are assessed by individual grading, which is according to the 7-point scale or Pass/Fail. The theme for the first semester is: designing from both sides of the screen. The semester has five modules and the project represents one third of the semester.

Table 2.: Overview of Medialogy – the first semester modules

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Semester  | Module  | ECTS | Assessment  | Exam | Type |
| 1st  | Creative Play – Applied Technology | 5 | Pass/Fail | Internal | Mandatory |
| 1st  | Designing from Both Sides of the Screen (Semester project) | 10 | 7-point scale | Internal | Mandatory |
| 1st  | Animation and Graphic design | 5 | 7-point scale | Internal | Mandatory |
| 1st  | Problem Based Learning in Science, technology and Society | 5 | Pass/Fail | Internal | Mandatory |
| 1st  | Introduction to Programming | 5 | 7-point scale | Internal | Mandatory |

The objectives of the first semester project are: “To provide the student with practical experience of defining a project within the area of IT, communication and new media, which includes use of object-oriented programming, to implement the project by working in groups and to document the solution in a project report” [8]. Further qualification goals for students who complete the project module are listed under knowledge, skills and competences. The qualification goals are related to Blooms Taxonomy [9].

**Knowledge** qualifications include, for instance, understanding how an object oriented programming language can be used to solve a specific problem; knowledge of commonly occurring data structures, algorithms and abstract data types and their application; the understanding of problem-based study and the Aalborg PBL model; and, knowledge of project management in a long-term problem based project (in this case from two to three months).

**Skill** qualifications include, for instance, the ability to apply media oriented methods and tools in the design and implementation of interactive media oriented projects; the ability to describe the theory, methods and practices of media oriented projects regarding a chosen technology, context and target group (analysis); the ability to discuss, argue, analyse and synthesize theory, methods and practices in media oriented projects, especially related to specific semester courses; and the ability to analyse individual as well as organizational learning processes by scientifically recognized concepts and methods (application)**.**

**Competence** qualifications include, for instance, using object oriented programming in solving programming tasks related to Medialogy, communication and IT/new media (application).

The exam is an individual oral examination, and is based on a written report, a media-technological product and an audiovisual (AV) production that illustrates and summarizes the project, plus a written process analysis. The assessment is performed in accordance with the 7-point grading scale (see Table 1).

The exam starts with the group’s presentation of their project, which must not influence the individual examination. In practice, before the examination, the censor (assessor) and the supervisor decide the level of the project and consider the problems in the report which should be discussed at the individual examination. After the examination the individual student in a group is given a grade. The project group very often get the same grade but sometimes there is a difference, which may be small or large (see Table 3).

Table 3: The groups and the individual group members’ grades

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Group | Grades |  | Group | Grades |
| A | 10 – 10 – 10 – 10 |  | L | 12 – 12 – 12 – 12 – 12 – 12 |
| B | 7 – 7 – 7 – 7 – 7 – 7 |  | M | 7 – 7 – 7 |
| C | 7 – 7 – 7– 7 |  | N | 7 – 12 – 10 – 12 – 10 – 7 – 4 |
| D | 7 – 02 – 02 – 7 – 02 – 7 |  | O | 4 – 02 – 02 – 02 – 4 – 4 |
| E | 7 – 4 – 7 – 7 – 10 – 4 – 7 |  | P | 7 – 4 – 4 – 10 – 10 – 02 |
| F | 7 – 7 – 7 – 7 – 7 – 7 – 7 |  | Q | 7 – 10 – 4 – 4 – 10 – 7 – 7 |
| G | 4 – 7 – 7 – 4 – 7 |  | R | 7 – 7- 4 – 02 – 02 – 10 |
| H | 10 – 7 – 10 – 10 – 7 – 7 – 7 |  | S | 4 – 4 – 4 – 4 – 4 – 4 |
| I | 10 – 12 – 12 – 10 – 10 – 12 |  | T | 10 – 10 – 10 – 10 – 10 – 10 |
| J | 7 – 7 - 7 – 7 – 7 |  | U | 10 – 10 – 10 – 7 – 10 |
| K | 4 – 4 – 4 – 7 – 7 – 4 |  |  |  |

As Table 3 shows, students in the same group do not necessarily get the same grade, and there might even be a big difference between the individual grades. However, the project is a common product which is the basis for the examination and for the final grade. So when a project is graded at 7 some students might raise their grade by one or two levels, and of course also lower their grade by a similar amount. However, the gap is very seldom more than two or three points.

The final result does not cover the project process and the performance as well as the results obtained during the project work; this is because it is not possible to grade the process of learning, only the results of the learning. The individual presentations often differ so much that it is difficult within the time frame to give proper feedback which covers both the project and the individual examination result.

***Case 2: The third year ECE design workshop, UMD***

The Electrical and Computer Engineering (ECE) design workshop topic involves the use of fuzzy logic to control comfort in solar homes [6]. In the workshop, students work in pairs, and are required to design, build and program a controller with intelligent behaviours using fuzzy logic. The project work is carried out according PBL principles [3]. This pedagogical approach implies that the students, within a theme, choose for their projects a problem they want to investigate and solve. In the 15 week workshop no formal lectures are provided; however, the students receive an intensive review covering the topics of the 68HC12 microcontroller, sensors, and fuzzy logic control. Since no formal lectures are taught in this workshop, an intensive review covering important material related to the specific topic is provided at the beginning of the semester. For the robotics and intelligent systems topics, the reviewed material includes the following: the MC68HC12 architecture and assembly language; an introduction to robotics, sensors for robotic applications, motors and drivers; and fuzzy logic. It is important to bear in mind that since this is a capstone design, students should be able to apply the knowledge and skills that they have learned on previous courses to solve problems that will emerge during the development of the project. This means that the students have to show the ability to use, combine and generalize knowledge gained previously in a new situation. Furthermore, the students have to organize how they work, contribute to their project, and set up detailed work plans.

In 2010 the ECE workshops had twenty students and two advisors/teachers. Pairs of students were formed and each pair was encouraged to develop ideas of their own and present a proposal for their project. All the proposed projects had to fit into the selected topic, and be reviewed and approved by the instructors. The students had 15 weeks to do all the work, from the initial definition to the development and completion of the project. The goal is that students should obtain specific technical knowledge according to the study programme as well as knowledge of group work, project management and communication skills. Students have to

* Complete a design project that is interdisciplinary in nature, integrating the knowledge obtained in previous ECE classes.
* Accurately communicate their project results, both in written report format and though oral presentation.
* Understand how teams work and how to interact in a team setting (including, understand what it is like to work in industry).
* Appreciate the role of engineering in society, and ethical issues.

The projects are evaluated in several stages, in both a gradual and continuous way. In the weekly meetings each pair presents progress on the evolution of their projects and receives guidance from their teachers. The objectives of these weekly meetings are also to closely observe each group’s progress and ensure that each group member is contributing to the project work. For the final grade, each member of a project pair obtains the same grade: 35% was assigned during week nine, when students presented a written report and an oral presentation of the results of their simulations; 35% was assigned to the students during week 15, when they demonstrated that their project is working in accordance with the specifications; and, the final 30% was assigned on the basis of the quality and clarity of the final oral presentation, the completeness of the final written report, and the quality of the poster.

The process competences are closely connected to the project work in general, and it is expected that the students’ performance reflects what it takes to carry out project work in a group. The students get feedback during the project about the project’s progress, and the relatively small numbers of students and teachers make it possible for the teachers to develop a profound knowledge of the standing of the groups with regard to the technical as well as the process competences. By the time of the final examination the groups have a strong impression of the quality of their project as well as of their processes, which is furthermore confirmed by the final examination and feedback.

**4. The challenge of giving useful feedback on student projects**

In the Aalborg case the students are individually assessed according to the results of the project and the knowledge they show during the examination, even though the project work in groups plays an important part of how they have reached their goal in the project. The teachers have weekly meetings with the groups, and are very aware of the learning process. Several milestones are put in place to follow the work and progress of all the project groups. The milestones include mid-term seminars, design briefs, and so on, where students present the actual situation and status of their project. Furthermore, the teachers have a common meeting after the students hand in their projects to discuss how to grade them. The projects from previous years are used as guidelines, but even after this discussions teachers often find it difficult to give grades according to the study regulation, as the many different dimensions related to knowledge, skills and competences make the grading complex.

Interviews with the teachers show that they use different methods to assess the project before the individual examination. They assess each dimension and then sum up with a final decision about the project grade. As part of assessment preparation, teachers assess the same projects and compare the results of their grading. It is interesting to note that even when using different methods, the teachers grades were the same for 90% of the projects, so the basis for the assessment of the individual project is quite solid regarding the point on the grading scale. When it comes to the assessment of the individual oral exam, the teachers’ approach is different. Some teachers base questions on the three dimensions in the study regulation, which the students can draw from a box; and some teachers have a number of questions related to different aspects of the report. All teachers state that it takes a long time to devise good questions as they have to prepare the questions for each report, and the reports are very different as students can chose which problems they want to solve in their projects.

All teachers say that they find it very difficult to give feedback in situations where individual grades differ by more than two points, as the grade for the project count for all students in the group;and all teachers state that it is very important for them to give immediate feedback to the individual student and to explain why the individual grade was given. Students appreciate the feedback and would like the process competences to be part of their exam results in a way that their future employers would understand. Another element of this process that teachers find difficult is that they know each student’s work performance during the project, but they cannot make use of this knowledge, as the results are based on the final project and the individual performance in the examination.

The UMD case shows that, with only two members in each group, it is easier to provide specific feedback to students. The assessment of the process is combined with a final assessment. The assessment of the projects is usually provided in terms of normal descriptive language, since the projects are too complex for a numerical assessment, and according to the teachers, is unacceptable. For example, when grading a final written report an assessment is based on several perspectives such as creativity, style, grammar, and so forth, and the final grade for the project is based on descriptors such as *excellent*, *very good*, *good*, *fair*, *poor*, and *unsatisfactory*, rather than on a numeric measure. The process of determining a grade for a specific report is seen as equivalent to the process of determining the membership of each of the evaluation categories, and this process is implemented through the composition operation [10].

**5. Conclusion and discussion**

In both the AAU and UMD cases different assessment methods are used. The AAU assessment purpose is to give a final judgment of the project together with an oral examination performance in topics related to the project, and it is based on a numeric grading scale. The UMD assessment is based on formative as well as summative purposes. The purpose of the UMD assessment is to give a final judgment of the process and the project, and together with an oral presentation the result is given by means of a descriptor representing categories on a scale.

The study shows that several assessment methods are in use in both cases with more or less emphasis on the different aspects in these methods. In the AAU case, the formative approach is used during the project process, but this should not formally influence the final result; however, according to the teachers this is very difficult. Regarding the assessment tools, each of the teachers has developed their own judgment system for project assessment based on the current grading scale and their experience and discussion with other teachers. All teachers have developed more or less complicated monitoring systems for the oral examination and for the purpose of giving good quality feedback to the students.

In both cases it is important to assess the process as part of the final results, and students expect feedback in normal language. The study regulations define the way the projects can be assessed, and the number of students in the project groups has a great influence on which methods the teacher can use when assessing the project and giving feedback to the individual students.

We suggest that a combination of the methods used in both cases should be used. The learning outcome should be measurable by the teachers, achievable by the students, and essential to the aims of the learning module. The assessment methods have to be able to evaluate all aspects of the students’ learning outcomes. As stated by Rothstein , “it is better to imperfectly measure relevant dimensions than to perfectly measure irrelevant ones” [11].

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