

Assessment Techniques used in Multidisciplinary and Cross-Cultural Student Teamwork

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Abstract

An international semester at the Engineering College of Copenhagen promotes international student teamwork. This initiative which started in 1995 is placed within the Export Engineering department. Very early on it was recognised that fundamental changes in working attitudes with a greater emphasis on multidisciplinary and cross-cultural environments highlighted the need for a different approach to education and training. As national borders blur, opportunities to work outside home countries are increasing, making mobility and international awareness part of an engineering degree. The project groups work together to execute an integrated engineering design and business project normally together with industrial firms. It is essential for the overall supervisor to guide by example and have regular feedback through tutorial discussion sessions. Videos can be used to assist subsequent analysis. In association with the progress milestones indicated in the project brief, each group submits an interim report. An oral presentation is also given by each group member in turn, all members are expected to answer questions on the report. Each student is assessed separately on his response to questions. In addition, group members grade each other's contribution (peer assessment). The supervisor applies a weighting factor so that a certain percentage of the marks come from peer review. The remaining marks come from the final presentation comprising staff involved in the supervision, experts from industry and external examiners. The seminar structure is oral presentation followed by rounds of discussion. To summarise, the assessment for this international semester has three elements:

1. Individual submission and oral presentation.
2. Team submission, details the proposed solution to the problem given.
3. Peer assessment.

Keywords: Project-based learning, Tutorial discussion, International teamwork, Group assessment, Peer assessment, Assessment of individual submission and contribution in group project work.

Introduction

Many observers consider that the present model of an engineering degree needs some adjustment in order to satisfy industry's requirements. Let us admit it, students suffer factual overload. Let us stop struggling trying to squeeze more knowledge into the existing scheme. Many people still believe knowledge to be paramount and tend not to make a distinction between insight and skills. To be able to make original and creative contributions as a responsible team member is important. To develop a thorough understanding of Integrated Engineering in modern context is important. Students need time and possibility to wonder and a stimulating educational environment to develop design project skills. This international semester is based on that idea. Also work done by Tranter and Bond¹ has shown how important that is to an engineering early carrier.

Needs of industry, university and students

Engineers must be capable of dealing with frequent and unexpected changes. We already provide them with a good basic knowledge of engineering, economics and management. But they also require training in a broader range of disciplines such as international communication, teamwork skills and languages. This semester is about international teamwork. We have experienced the structure of the semester to be a programme which fulfils the students need to learn and their wish to be of use to the engineering profession. However, since the number of students of disciplines other than engineering can participate and has increased over the last few years, we have found it necessary to adjust the scheme accordingly. To strengthen the project-based learning part students are given knowledge on creative problem solving and systematic innovation techniques early on in the course. Also the connection between a project group and its supervisor has been improved. A weekly meeting with agreed agenda is now compulsory so that the supervisor gets a better feeling of group behaviour, inside group communication and the work process. Students work in internationally mixed project groups of four to six persons. They work on real projects provided by Danish or foreign firms and they are very keen to apply their skills. Through this contact with industry they experience the practice of the profession. They learn to co-operate, to communicate and they learn to discuss and negotiate. In fact it has shown that they learn good judgement tinged with sagacity. Sixty five percent of the semester is presently international teamwork and this percentage will probably increase on future courses. In the remaining time students participate in short intensive and project supportive courses taught traditionally. They also attend courses, taught by members of the supervisor team, guided by immediate need expressed by the project groups. In general courses are chosen to augment the work being done on the industrial project. A major aspect of the importance of the project work derives from the students own planning. Also programming of the process from project formulation to submission of the group project report.

Supervisors

The main contribution of the academic supervisor of the project is to help the students understand the content of their project and ensure that they are making progress. It is also to nurture and facilitate group work and the group process. The supervisor must make sure that the advantage of working in groups is sustained. The work has to be completed with-in the time schedule and to be presented at an assessment meeting. Great attention is paid to plan and delegate, communicate and to co-operate as a responsible team member towards a common objective.

Industrial projects and international group-mix

Below is shown projects and groups involved in the autumn semester of 1999:

1. Development of a Software Application Programme (Lit., E, D, UK, PL)
2. Developm. of a Mechanical Coupling for the RUF (Rapid Urban Flexible) System (D, PL)
3. Industrial Ecology (UK, NL, E, Fin)
4. Information Technology (UK, PL, DK)
5. Development of a Golf-Ball Collecting Machine for the driving range (NL, E, UK)
6. Use of alternative energy to heat a Leisure Pool (D, Hun, Chile)
7. Design of an Olympic Pool (NL, E, UK, D)
8. Design of a "Green Hotel" (DK, Hun, PL, UK)

Group project work

Project work involves collective activity in which decision making proceed through stages such as:

- Understanding of project statement given.
- Recognition of need.
- Development of ideas.
- Evaluation.
- Selection of solution
- Implementation.

It is important in teamwork that at any particular time the members of the team know what they are each doing and why. It is recommended that one of the team members act as project manager leading the project process, keeping track of the work being done. Also to encourage members, of the group, to hand in their contribution in accordance with agreement.

Organisation of work

To help organise the work it is required that each team makes a Logbook and a Project Folder. All decisions made and all plans and revisions are described in the Logbook. Also information about meetings, minutes and reports are placed there. The Project Folder contains individual contributions to the group project. Also the project formulation, investigations made, specifications, concept design, detail design, calculations made, manufacture, economics etc. The folders are accessible to the leading staff and supervisors any time throughout the project period.

Project execution

In order to meet the aims and objectives of the team-based project, specified in the syllabus, students are advised to adopt the following procedures:

1. Problem identification, project formulation, aims and objectives, tasks to be carried out and specification.
2. Analysis of available knowledge, techniques, constraints and resources.
3. Synthesis of the relevant components of this information to indicate possible routes to the problem solution.
4. Evaluation of possible routes and a decision made upon the optimum route to be adopted.
5. Production of a planned timetable of goals to be reached at the various stages in the activity in order to meet the problem specification.
6. Execution of the plan with modifications made for obstacles not foreseen at the beginning.
7. Careful recording of the results achieved and evaluation of their importance.
8. The achievement of the planned goals.
9. Comparison of the achievement reached with the initial specification and the planned achievement.
10. Communication of the entire project activity for assessment, in terms of the documentation and presentation requirements.
11. The documentation should contain a main section describing, in a clear and easy understandable language, the work carried out. An external reader should by continuous reading be-able to grasp the context of the work carried out.

In each stage of the problem-solving strategy outlined above, there are well-defined tasks, that must be performed, skills to be learned and attitudes to be developed. All the tasks, skills and attitudes are required to a greater or lesser extent, depending of the specific nature of the problem undertaken. There should be regular contact with the project supervisor(s). It is crucial that the work done on the project is evenly distributed through the group, so that the standard of assessment can be harmonised.

Study programme

The following subjects are included in the programme:

- Environmental Studies
- Intellectual Property Rights in Europe
- Communication Skills (Teambuilding)
- International Marketing
- Project Management (Theory and applications)
- Simultaneous/Concurrent Engineering techniques
- Engineering Product Design
- Creative Problem Solving and Systematic Innovation Techniques
- Languages (English and Basic Danish)
- Cultural and Social Activities

Staffs of the host institution and visiting lecturers from English Universities teach these courses.

Assessment

Marks are derived from the following sources:

- Supervisors and external examiners allocate up to 80% of the marks from observations of team/student conduct and progress, and from the documentation submitted.
- Student oral presentation and participation in discussion 20%
- Evaluation of student participation in the study programme courses after deliberation and discussion with the course lecturer and a short course exercise
- Peer assessment

Further, all courses and activities are evaluated using specially formed appraisal sheets.

Detailed assessment procedure

Although a list of headings is given for marking criteria, no attempt is made to allocate marks for each heading as the degree of importance differ with each project. Marks are derived according to the following:

Project execution (Teamwork) 35%:

Heading

1. Approach to project
2. Initiative shown
3. Work rate/motivation
4. Judgement/discrimination
5. Quality of work
6. Achievement

7. Degree of difficulty
8. Supervisor requirement
9. Interaction with supervisor

Documentation set (Report submitted) 45% :

Professional technical content 25%
 Communication 20%

Heading

1. Style
2. Structure
3. Content
4. Background
5. Statement of objectives, discussion of results and achievements made
6. Conclusions and recommendations

Oral presentation 20% :

In particular consideration is given to style, structure and content.

Consideration of peer assessment

During the course we follow the teamwork closely to make sure that the advantage of working in a group is sustained. Assessment of the course has the following elements:

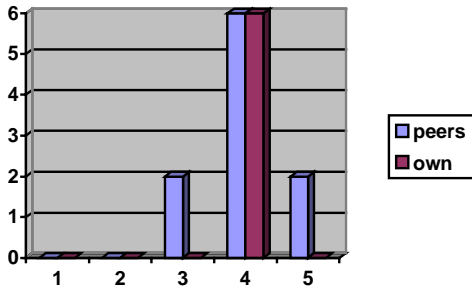
1. Individual project execution (teamwork) and oral presentation (55%).
2. Team submission of project report, which details the proposed design solution to the problem given (45%).

The difficulty lies in apportioning credit for the team submission to individual team members. In an ideal situation, equal credit is given to each member of the team. In practice, however, members individual contribution will vary both in quality and in quantity. For this reason a system of peer appraisal is used to accomplish this apportioning of credit and achieving a fair spread of marks. To follow and assess the group process, however, is difficult but important. The advantages of working in groups are often lost because of faulty group processes, which degrade the cognitive and political problems of the group. A weekly meeting is held between a project group and its supervisor. This gives the supervisor the opportunity to work closely with the team. Minutes are made of all meetings and a copy is kept in the group project folder. Every other week during the semester the supervisors meet to discuss matter of concern experienced with the project groups. The following seven questions are asked twice during the course. Students are asked to circle the numbers from 1 (lowest) to 5 (highest) that most accurately reflect their opinion:

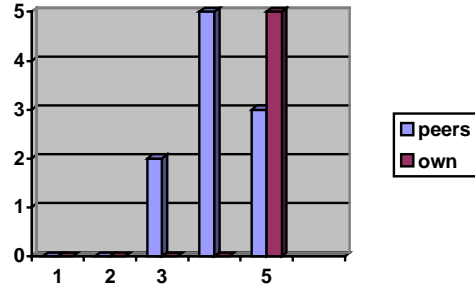
1. Technical contribution in major field (quality)	1	2	3	4	5
2. Technical contribution in major field (quality)	1	2	3	4	5
3. Willingness to build upon the idea of others	1	2	3	4	5
4. Understanding of the team process	1	2	3	4	5
5. Leadership at the appropriate times	1	2	3	4	5
6. Positive attitude	1	2	3	4	5
7. Initiative	1	2	3	4	5

The assessment has the following elements:

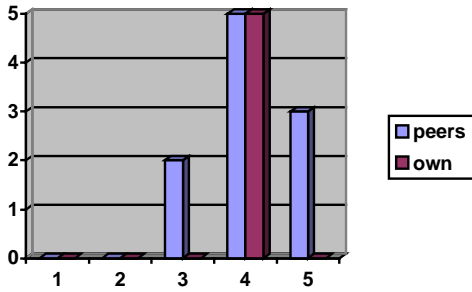
- Individual contribution to the group report (the group work) question 1 and 2
- Individual contribution in the teamwork (the group process) question 3,4,5,6,7



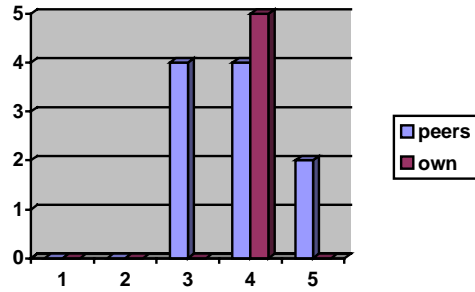
1. Technical contribution in major field (quality)



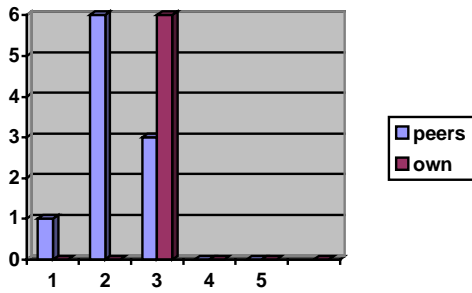
2. Technical contribution in major field (quantity)



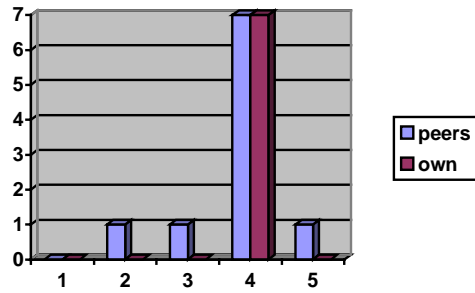
3. Willingness to build upon the idea of others



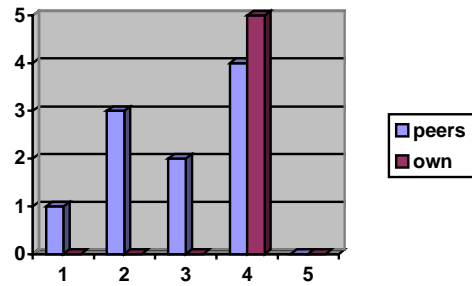
4. Understand of the team process



5. Leadership at appropriate times



6. Positive attitude



7. Initiative

Figure 1 Peer assessment graphs

In figure 1 is shown 7 graphs results of peer assessment, done twice during the course, of one student in a group of six. The red/dark column is the student's own opinion. The blue/light columns show the peers opinion.

Weighting Factor

In addition students as well as supervisors are asked to distribute 100 points among the team members. An example of this is shown in table 1. Often it takes some time and discussion to do this, but we have found a great interest in performing this task.

Student	A Peers	b Sup/Tutor	Average A = (a+b)/2	Weighting Factor WF	Remarks
B	20	18	19	1.4	WF = A/c
C	16	16	16	0.96	
D	15	16	15.5	0.93	
E	15	16	15.5	0.93	
F	18	18	18	1.08	
G	16	16	16	0.96	
Average c	16.67				

Table 1 Individual contribution in teamwork. Weighting Factor WF

Final examination

Assessment of the project execution (teamwork) is done continuously by the project academic supervisor during the project period. If the weighting factor WF is different from 1.0, as shown in table 1, it will influence the final mark. An example of this is shown in table 2 and table 3 used at the final examination.

Student name: F

Point	1	2	3	4
Supervisor 1	10	9	9	10
Supervisor 2	9	8	9	10
Examiner 1	9	8	9	10
Examiner 2	10	9	9	10
Average	9.5	8.5	9	10
Weighting Fact.	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	1.08
Point 4 weighed	XXXXXXXXXX	XXXXXXXXXX	XXXXXXXXXX	10.8

Table 2 Allocation of marks

Supervisors and external examiners allocate their marks as shown in table 2. The average of each point is calculated. The result in point 4 is multiplied with WF = 1.08.

Point 1. Student oral presentation

Point 2. Professional technical content of report submitted

Point 3. Communication value of report submitted

Point 4. Project execution (teamwork)

Assessment	Average from table 2	Distribution factor	Final mark
Oral presentation	9.5	0.20	1.90
Professional techn. content	8.5	0.25	2.13
Communication value	9.0	0.20	1.80
Project execution	10.8	0.35	3.78
XXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXX	XXXXXXX Sum:	9.61
XXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXX	ECTS: B+

Table 3 Final mark calculation

The marking is done using the Danish marking scale and transferred in accordance with the European Credit transfer System ECTS. The final exam, held as a board meeting, is a seminar where the above mentioned four points are discussed with the team. Time allocated is half an

hour per student i.e. two hours for a group of four, three hours for a group of six etc. Between each session there usually is a break of five minutes. Assessment may be done in many different ways depending of the regulations of the sending university. It is crucial that work done on the project is evenly distributed through out the group so that the assessment can be harmonised. Details of assessment can be negotiated between involved universities if necessary.

Marks table

Overleaf, table 3, room is provided for specific comments regarding any particular heading. Also comments of a more general nature can be noted.

Tutorial discussion sessions

A means of assessing fairly the individual performance of each member is important and a necessary requirement. It is essential for the project supervisor to guide by example and have regular feedback through tutorial discussion sessions. Performance sheets used at such occasions contain the following six points to be assessed:

1. Observation of time
2. Content/structure
3. Clarity/visual aids
4. Style/appearance
5. Questions/response
6. Overall impression

The assessor is asked to circle numbers from 1 (lowest) to 5 (highest) to reflect his opinion. Also the audience is asked to fill in the performance sheets and hand them over to the speaker after each presentation and discussion. This gives the presenter a real chance to use his oral presentation skills and make improvements based on real feedback.

Academic recognition

Universities sending students to participate in this semester must make sure that the course is an acknowledged part of their degree. The semester long course is a 30 ECTS credit (European Credit Transfer System) course. The international teamwork amounts to 20 ECTS credit points equal to 360 hours of work for an average student. The study programme courses contribute the remaining points.

Conclusion

Engineers commonly describe themselves in terms of a specific discipline, a convention increasingly misleading. Very few engineers work totally within the confines of a single discipline or industry. Fundamental changes in working attitudes with a greater emphasis on multidisciplinary and cross-cultural environments highlight the need for a radically different approach to education and training. It is extremely important that industry is showing interest in and support of international development in education. Industry's involvement has important ramifications for educators who have substantial opportunities to benefit from increased contact with firms outside the college or university. I do believe that properly managed programmes of co-operation are of great importance and can be of mutual benefit. After graduation students should be competent to work in industry and commence work immediately⁵. This was identified by the Engineering Council of Great Britain in 1988 and

supported by the Design Council of Great Britain in 1991. As a result the Engineering Council initiated the “Integrated Engineering Degree Programme” which defined a new type of broader based engineering degree. We as educators must constantly look at interesting trends that may illustrate where engineering careers are going. The new ABET 2000 eleven point program should be observed with great interest. In my opinion this program certainly try to create a competent graduate ready to perform work immediately. We must try to predict what knowledge and base skills is needed by the new graduates if they have to make the transition from college to work smoothly and perform successfully². One way to prepare for tomorrow is to have a thorough understanding of today.

The future

The Danish society develops towards a more and more service oriented society. The manufacturing industry will be highly automated with increasing use of robotics. Our engineers should therefore have a solid knowledge and insight in those fields of technology. International awareness and environmental concern is extremely important and we must find and develop responsible ways to increase production³. The number of people on this earth is expected to double within the next 50 years. Greater integration of disciplines and use of consultants when developing products or projects will be required. The future engineer must be able to cope with frequent changes. He must have a solid basic engineering knowledge combined with the ability to tackle problems alone and find solutions in co-operation with other people in international teamwork. The link between education and industry must be developed and strengthened. Projects provided by firms must be of real concern to the company. Time must be allocated to involve company advisors to work interactively with the project group.

Closing remarks

It is predicted by researchers that work in year 2020 will be measured in responsibility, not well defined but a measure in itself. Work and leisure will merge making the situation more blurred. Jobs will be short time contracts rather than permanent employment. Employers will be more interested in buying competencies rather than working hours. This trend is already developing in Denmark at the moment⁴. Many families are struggling trying to fit workload in with family life. Future companies must allow the young families to cope with the dilemma between requirements and flexibility and their own need to fit work in with family life.

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Biography

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J.Arvid Andersen is a registered professional Eur Ing. He earned his B.Sc in Mechanical Engineering from Ingeniørhøjskolen i Odense, Denmark in 1961 and his M.Phil/Ph.D from Cranfield University in England in 1996. He has worked both in Switzerland, USA and Denmark. For 21 years he has been Associate Professor of Mechanical Engineering. In 1995 he invented and started European Project Semester (EPS) which is about International Teamwork. He is now course director of EPS located in the Export Engineering Department at The Engineering College of Copenhagen, Denmark.