Group assessment challenges in project-based learning – Perceptions from students in higher engineering courses

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***Abstract* — Industry and society want to recruit students who can work in team-based projects. Thus the task for educators in higher education is to prepare and provide such learning environments. However, assessment is one major challenge associated with enacting these learning environments. The literature advocates active team learning but then supports individual assessment modes. The purpose of this paper is to identify and elaborate on group assessment challenges for students and educators in project-based learning. The research is based on a literature review in the field of project-based learning and group assessment. It is empirically supported by action research in three classes of university engineering students. The findings point to an assessment dilemma, which requires a change in mind-set from individual to team/group grading. The students prefer group learning over written exams. However, when it comes to assessment, the majority want individual grading. Individual assessment is perceived as more fair but unnecessary for learning. Furthermore, a challenge identified by educators is to ensure that all individuals have achieved the learning outcomes. At the same time, they find it frustrating to make individual assessments when the course is based on group learning.**

***Index Terms* — Assessment, Group work Project-based learning, teamwork**

I. Introduction

Learning in teams or groups is common in higher engineering education. A review of courses at Lund University's Faculty of Engineering shows that the majority of them, especially late in the programmes, involve group exercises and teamwork. Several of these are organised as team-based projects and the assessment is, at least in part, based on the project outcome. Thus, educators are faced with the dilemma of assessing a team of students but grading individual team members.

Project-based learning is an active learning environment that has grown in popularity the last decade. Mills and Treagust [1] argue that 'the use of project-based learning as a key component of engineering programmes and should be promulgated as widely as possible, because it is certainly clear that any improvement to the existing lecture-centric programmes that dominate engineering would be welcome by students, industry and accreditors alike'.

Assessment is one major challenge associated with implementation of project-based learning. Research findings from Marx et al. [2] indicate that educators enacting project-based learning have difficulties in designing assessments that enable students to demonstrate their knowledge and skills. Research by Helle et al. [3] concludes that there are several challenges in demonstrating reliability of assessment (e.g. who should do the assessing and on what evidence/criteria the grade should be based). Additional challenges are: how should the contribution of each team member be weighted in the grade? If the project outcome is different from the sum of each team member's contribution (lower or higher) – how is this assessed? If the teams differ in form and size – how adaptive can the assessment be? Do all merit the same grade even though students contribute differently to project? Based on these challenges in assessing team-based projects it would be interesting to explore students opinion and perceptions of these challenges.

The purpose of this paper is to identify and elaborate on group assessment challenges for students and educators in project-based learning. The focus is exclusively on three classes of engineering students in higher education at Lund University. It provides insights into critical aspects to be considered when assessing the subject matter competence of students.

The remainder of the paper is organised as follows: Section II presents a literature review; Section III, methodology; Section IV, course descriptions; and Section V, results and discussion. Concluding remarks are presented in the last section.

II. Literature review

This section begins with a general overview of project-based learning and a discussion concerning its assessment. This is followed by a brief review of group assessment. The specific focus is on literature related to higher education.

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A. *Project-based learning*

Project-based learning is a well-known example of an active learning environment which focuses on learning through experiences [4]. Essentially, project-based learning is a student driven investigation of a complex question or problem that serves to organise and drive learning activities which culminate in a final product that addresses the question or problem [5]. The result is that students develop deeper levels of understanding, problem-solving, and communication skills that help them both in academia and the future workplace [6]. To capture the uniqueness of project-based learning, Thomas [7] provides five criteria that characterise a project-based learning activity:

- Projects are central, not peripheral to the curriculum.
- Projects are focused on questions or problems that 'drive' students to encounter (and struggle with) the central concepts and principles of a discipline.
- Projects involve students in a constructive investigation.
- Projects are student-driven to a significant degree.
- Projects are realistic, not school-like.

Although these criteria characterise project-based learning, it can assume a variety of orientations in practice. Heitman [8] has identified four main orientations for project-based learning in the last century: (1) professional, (2) society, (3) science criticism, and (4) education. The motive of professional orientation is to bridge the gap between theory and practice, and satisfy the needs of industry, society and the labour market. The society orientation has domestic and humanitarian motives to foster democracy and improve society. The science criticism orientation aims to foster critical thinking and highlight the need for multi- or interdisciplinary research and education. The educational orientation has the pedagogic motive of using problem-centred and active learning methods to foster holistic personal development.

Research literature on project-based learning is both voluminous and heterogeneous (see [3] and [7] for reviews). Quite often, the research focuses on evaluating the effectiveness of project-based learning. For example, there are studies that look at students' science achievement performance [9]. Other literature focuses on implementation challenges associated with enacting project-based learning, a major one being assessment.

B. *Assessment in project-based learning*

Assessment and student learning is inextricably linked [10;11]. What and how students learn depends to a great extent on how they think they will be assessed [12]. This implies that assessment is a tool for learning, which can strategically be used in a learning environment to gain better learning outcomes.

In project-based learning, students have been assessed in a variety of ways: from conventional written tests to more innovative modes of assessment such as self assessment, peer assessment, co-assessment, portfolio assessment, performance assessment and reflective journals [13]. According to the literature, conventional assessment methods do not support students' understanding and skill acquired from project-based learning [14].

As a result, researchers have proposed new alternative assessment modes consisting of a combination of assessment methods. Tal et al. [15], for example, present a multi-dimensional assessment scheme in a number of ways:

- Collaborative assessment using external and community experts, teachers, and students;
- The use of multiple assessment tools: studies, project product exhibition, product portfolios and self-assessment; and
- Assessed objects are both the individual student and the team.

Even though the team often is the object that is assessed, the proposed new and alternative assessment modes still focus on individual students and not the project team itself. Individual assessment compared to group assessments does not test or promote the complex knowledge construction process combining knowledge (e.g. content and methodological knowledge) and skills (e.g. conceptualising and analysing engineering problems) in project-based learning [16]. According to Blumenfeld et al. [5] project-based learning may require a shift in thinking about assessment.

Katzenbach and Smith [17] in their research on working groups and teams states that: 'A team strives for something greater than its members could achieve individually. In short, an effective team is always worth more than the sum of its parts.' This becomes a contradiction to the discussion held in most of the project-based learning literature where assessment should be based on the individuals' contribution (i.e. a reductionistic assumption that does not fit with the synergetic perspective of teams).

C. *Group assessment*

Extensive literature exists on co-operative and collaborative learning in groups and teams. Group assessment has received far less attention in the literature, nevertheless, there are some studies reported (e.g. [18;19]). A majority of these studies conclude that assessment of team-based projects is problematic. Moreover, the main assessment modes that are investigated and used in practice are assessing the group product/result and then distributing this grade through some form of peer assessment [20]. This goes against the core of teamwork thinking in which the team have worked and performed as one unit and needs to be judged as a unit. Thus, it is questionable if these studies deal with group assessment per se or individual assessment based on group/teamwork.

Gibbs [21] and Mello [22] present the following benefits of working and being assessed in groups:

- Students gain insight into group dynamics;
- Group assessments allow the development of more comprehensive assignments than possible for individual assessments;
- Group assessments develop students' interpersonal skills;

- Students are exposed to other points of view;
- Students are prepared for the real world;
- Increases the amount and quality of discussion between students and fosters informal peer tutoring and peer feedback;
- Produces better quality learning outcomes than any individual student could manage; and
- Increases co-operation between students

III. Methodology

The study presented here is based on three teachers' collected experiences from running project-based learning courses in the final year of a master's programme in engineering. The teachers have continually developed courses based on student input from course evaluations and discussions. It can be argued that this method is based on action research and action learning methods [23]. Student input is provided in course evaluations; teachers link this input to theoretical aspects of pedagogy, and thereafter implement new ideas that the students evaluate again. The iterative method corresponds to the learning loop introduced by Kolb [24], and the action research spiral introduced by Gummesson [25].

However, two critical aspects for the teachers have been how to assess teams/groups in project-based learning and how to secure that all students have achieved the learning outcomes of the syllabus. The challenges of group assessment were discussed by the three teachers and to structure the experiences, a combination of qualitative and quantitative data was collected to elaborate on these experiences.

The exploration of students' opinions and perceptions of group assessment were followed unstructured and qualitatively over the years. The input was from three courses (described in Section IV) on the master's level in an engineering programme. Empirical insights were gained by carrying out semi-structured interviews and discussions with either teams of students or with individuals from the three courses over two years.

In order to better structure the data, the input from discussions and interviews was collected in written form by the teachers during 2009. In addition, a questionnaire with three questions was distributed in one course. In question 1, the students were asked to rate whether they liked or disliked the exam (1 for dislike and 5 for like very much) and in question 2, whether they thought an exam was necessary in this course with team assignments (1 for remove, 2 for replace, 3 for improve, 4 for necessary and 5 for absolutely necessary). A third open-ended question solicited their opinions on removing the exam and using group assignments as the only means of assessment.

IV. Course descriptions

In the Innovation Engineering course, 75% of the assessment is based on teamwork/tasks and 25% on individual work/tasks. Two projects are carried out: an innovation audit of an organisation and an innovation project where that results is a business plan. The teams consist of 6-11 students with the same goal (create a business plan for a new innovative product) and underlying assessment criteria (innovation potential, creativity, feasibility, completeness, and process).

In the Packaging Technology and Development course, 50% of the assessment is based on a team-based project, 10% on a group assignment and 40% on an individual open book written exam. The project and group assignment are graded with pass or fail, while the exam is graded fail, 3, 4 or 5. The project is based on multidisciplinary teams, made up of people with different nationalities and preferably represented by both gender.

In the Packaging Logistics course, approximately 60% of the individual assessment is based on the project and 40% on an individual open book written exam. A project is carried out in teams of three and is assessed using the grades; fail, 3, 4 and 5. Formative assessments are carried out during the whole course to provide the project teams with feedback. The teams (3-4 students) are formed by the teacher with the aim of constructing multidisciplinary teams in which the students have similar ambitions.

In all three courses the projects are realistic and carried out in close co-operation with industry. They are based on unique problems that drive the student to investigate the central concepts and principals in the courses, which correspond well with the criteria presented by Thomas [7].

V. Results and discussion

Students' opinions and perceptions of group assessment in project-based learning is presented and discussed.

A. Student perspective on group assessment

In total, 45 students in the one course completed the questionnaire; 42 rated the questions about whether they liked the individual exam or not, and if it was necessary to have them when the course is project-based. The results from this quantitative portion are shown in the graph, Fig. 1.

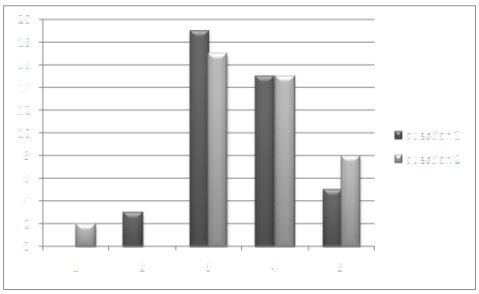

Figure 1: Student responses to individual assessments.

The graph shows that the students liked the exam, and that they felt it necessary to have one. Two students, however, showed that they did not like having an exam in combination with a project. The majority of the students, though, chose the middle alternative when ranking, which means that they think the exam is acceptable, but that it should be improved.

By examining the qualitative answers linked to each

quantitative answer, it is clear that students want the exam as a complement to the project. They suggest the project to be graded with numbers rather than with pass or fail. They also want the project to be at least 50% of the final grade of the course; however, they still want to keep an individual part as evidence of their individual level of knowledge and understanding. This is similar to the insights gained in the other courses. One student described it as, 'You do not learn something new in the written exam that you have not already learned in the project. However, I still want the written exam in order to get a fair individual grade'.

Based on this, some students were asked if a peer assessment of each individual contribution could be a way to achieve a fair grade. Students commented that this would be acceptable and probably even somewhat improve their motivation in participating more actively in the project. Surprisingly, hardly any students questioned their ability to assess peers in a group setting.

B. The student motive to individual assessment in group work

From the interviews and group discussions on assessment of team-based projects combined with the students call for a 'fair' individual assessment issues concerning student ambition where raised. For some students, identified as very ambitious with a focus on learning, their knowledge and skill development was limited by the ambitions of the team in total; hence they wanted more individual assessment to be more motivated and to get credit for their willingness to learn. For most of the other students, the focus was mostly on the outcome/result (i.e. making the least effort for the highest grade). Based on several observations of and discussions with the teams, this outcome view results in finding as quickly as possible a working method (task separation, etc.) and for every new task, increasing the effectiveness of the method rather than trying something else (e.g. a new method or approach, that could improve learning from the process as well as improving the final results).

Van Der Vorst [26] has experienced this conflict between highly ambitions students versus lower ones who do not want to pull the same weight. To solve this conflict a decision was taken to award the group with a group grade multiplied be the number of group members to be distributed among the group members by themselves. This decision was greeted with general enthusiasm by the students and might even have motivated students to participate more. However, even if this decision generated more student motivation, which in turn improves learning, it is not aligned with teamwork and team assessment philosophy.[26]

C. Groups size

In the interviews and group discussions, students also pointed out the difference in team size and its effect on the final assessment. This was especially raised by the teams that had fewer students. They requested a linear model of assessment (i.e. that their results should be directly proportional to the number of team members). However, according to Katzenbach and Smith [17], an effective team is always worth more than the sum of its parts; hence it should be an exponential model of assessment. In practice, however, the three course teachers use a pareto model.

D. Groups formation

The way in which a group is formed seems to have an effect on group performance. Lejk et al. [27] have compared the performance of streamed and mixed-ability groups and conclude that if a strong correlation between grades obtained from group assessments and individual assessments is desirable, then streaming groups is a way of achieving this, especially when each group member is awarded the same grade. However, streaming groups could be argued as prejudging students, while in mixed-ability groups students can be advantaged or disadvantaged because of the group members they are working with.

With the aim of forming high performance groups, without prejudging or treating students unfairly, the students in one course were grouped into teams in which the members had similar ambitions. A vast majority of the students found this positive in two ways. First of all they had to take an active individual decision on what learning ambition they had in the course. This is not usually the case, where the learning ambition is an outcome of various course and social aspects. Secondly, when they then met their team members they were allied and already had a joint goal to pursue. However, these students still wanted an individual assessment to 'guarantee' that the grade is fair.

VI. CONCLUDING REMARKS

There is much literature on project-based learning and its assessment. However, the literature clearly presents a contradiction where assessment should be based on the individuals' contribution (i.e. a reductionistic assumption that does not fit with the synergetic perspective of teams).

Discussions with students involved in project-based learning groups confirm this view. Students prefer group learning in favour of written exams. However, when it comes to assessment the majority of students want some kind of individual grade. The individual assessment is perceived as more fair but unnecessary for their learning. Empirically educators have identified it as a challenge to ensure that all individuals reach the learning outcomes but at the same time they find it frustrating to make individual assessments when the course is based on group learning.

These student and teacher perception corresponds to the mainstream literature on assessing individually, even if the main portion of course assessment is based on work performed in groups and projects. Theory as well as empirical data shows that there is a need for students and educators to learn the philosophy of teamwork and team assessment. This requires a change in mind-set from individual to team/group grading.

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