Team Work Breakdown: a tool for increasing individual accountability and integrated learning across group projects

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Structured abstract

BACKGROUND
Assessing individual contributions to group projects continues to be a challenging task in engineering education. In addition, unless held accountable, when given a group project, students will complete their individual project components, without learning aspects about other student work contained within the same project. This paper describes the evolution of a teaching tool called a Team Work Breakdown (TWB), which students use to document their contributions to a group project. The paper describes the implementation of the tool and instructor feedback on the use of the tool.

PURPOSE
In the context of group projects, the goal of the Team Work Breakdown learning tool is to increase individual accountability as well as promote integrated learning for each student across the entire project.

DESIGN/METHOD
This study uses Participatory Action Research as an approach to improve one's own teaching methods. The instructor researches his or her own practice through a cycle of plan, intervention, observe, reflect and plan again. In this study, the instructor developed the Team Work Breakdown, and improved the tool thorugh two cycles of use. Students are required to complete the Team Work Breakdown at the beginning of their projects. Students are required to modify the TWB as the project progresses to reflect the actual contributions of team members. Students must document their contributions in their end of semester portfolios. Students are interviewed after their portfolio has been evaluated. Students are asked to discuss team work as well as what they learned from completing the project.

RESULTS
Instructor observations on 1) how the use of the TWB evolved and, 2) how students engage in the material are presented. Now that students are required to use the Team Work Breakdown as part of managing their team process, student learning has changed in the following ways. 1) Students learn more about the project earlier in the term in order to complete the TWB. 2) Students learn more about different aspects of the project because the TWB requires each student be the lead on some project tasks, but also requires students support leaders of other project tasks. End of term student interviews verity this outcome. 3) The instructor no long uses peer evaluations as part of team work assessment, as students have the ability to modify the TWB to reflect the amount of contribution of each person until the project is submitted at the end of the term. 4) Students now receive more practice in two important project management skills: project scope management and project time management.

CONCLUSIONS
The implementation of the TWB has improved the scope of student contributions to group projects, thereby improving the breadth of topics students learn. Students practice project management skills using the TWB. In addition, the TWB provides a mechanism to promote individual accountability to the point that students in third year courses are no longer required to submit a peer assessment.

KEYWORDS
Group work assessment, individual accountability, project management, portfolio assessment, Project Based Learning assessment.

Introduction

Central Queensland University (CQU) offers two unique degree pathways in engineering – one with a Co-op experience (the dual award program Bachelor of Engineering (Co-operative Education)/Diploma of Professional Practice (Engineering) (Jorgensen and Howard 2005a)) and one with Distance Education option, but no Co-op option (Bachelor of Engineering). Approximately 27 percent of the CQU enrolled engineering students (19 percent EFTSL) take their courses as part of the distance education program. Both of the degree options integrate Project Based Learning (PBL) in all years of the degree program (Howard and Jorgensen 2006).

While the learning benefits of cooperative learning and teamwork are well documented (Springer et al. 1999), assessing the learning of individuals that contribute to a team project remains a challenge. As described in Eliot et al. (2012), students, instructors and accrediting bodies are still grappling with determining which assessment tools are most appropriate to determine an individual grade in a team setting.

Portfolios are one approach used to assess student learning outcomes in PBL team-based courses (Jorgensen and Howard 2005b). The goal of portfolio assessment is to appropriately assess students' individual contributions to team efforts and verify that students have achieved stated learning outcomes. While using portfolios to assess student work in PBL courses has become standard practice at CQU, portfolio assessment is difficult (Jorgensen and Senini 2005).

At CQU, students are required to submit a portfolio of their work that demonstrates the achievement of required learning outcomes as well as the degree to which each learning outcome was achieved. Students are invited to include a subset of the following as part of their portfolio: technical workbooks, design journals, project reports, audio-visual presentations, skills audit tests, peer evaluations and reflective journals (Jorgensen and Senini 2005).

Students are then required to self-assess to the degree they have met each required learning outcome. Students nominate a grade for the course based on published criteria. Students then come to a final interview where they are expected to defend their grade with the evidence presented in their portfolio.

This paper focuses on two difficulties associated with teaching and learning using group projects: 1) How to better promote individual accountability in team setting? and 2) How to motivate students to learn about all aspects of the group project?

Background

One approach to improving ones teaching practice is Participatory Action Research (Shon, 1987; Herr and Anderson, 2005). Action Research (AR) can be used to research one's own practice using a cycle of plan, intervention, observe, reflect and then plan the next intervention again. AR is a self-reflective method and focuses on the improvement of ones own practice and usually not the practice of others (McTaggart 1989). Thus, results reported are the reflections of the instructor and do not focus on the experiences of the student, except from the instructor's perspective.

One difficulty with team projects is, unless held accountable; some students will complete their individual project components, without learning aspects about other student work contained within the same project. Good design of cooperative group learning assignments avoids this type of problem. The five essential elements of formal cooperative learning groups are 1) positive interdependence, 2) face-to-face promotive interaction, 3) individual accountability/personal responsibility, 4) teamwork skills and, 5) group processing (Smith et al. 2005).

One approach to promote individual accountability in a team environment is peer assessment or peer evaluations. As discussed in Ohland et al. (2012) there are difficulties with self- and peer evaluations if not implemented carefully. Some difficulties include leniency errors with self-evaluations (Inderrieden et al., 2004) and that the unskilled cannot recognise the lack of their own skills (Kruger & Dunning, 1999). Thus, students with poor teamwork skills are not able to provide as accurate ratings of teamwork skills of themselves or others (Jassawalla et al, 2009). Another challenge is determining each team member's contribution when team members' assessments do not agree. It can be difficult to ascertain evidence to support each student's peer evaluation. Thus, instructors using peer evaluations to assign grades should do so with care. Their students likely require or would prefer to have training in how to perform such evaluations (Ohland et al. 2012; Walker 2001). (Please note that this discussion ignores the potential benefits of formative feedback on teamwork skills if peer evaluation is applied multiple times over a term (Sheppard et al., 2004)).

Another approach to promote individual accountability is to require the team to develop at the beginning of the project a single summary of the anticipated contributions of all team members. Students then update that summary throughout the project and submit the final summary at the end of the project. In addition to instilling individual accountability, this type of approach can help students develop important project management skills that are desired in industry. Panuwatwanich et al. (2011) completed a survey of industry leaders that determined the three highest ranked project management knowledge areas were 1) project scope management, 2) project time management and 3) project cost management. These rankings were based on both what industry leaders thought should be emphasised as well as where performance gaps were noted in new engineering graduates.

This paper describes the development and use of the Task Work Breakdown (TWB) tool in a third year PBL Water and Environmental Design course. The purpose of the TWB is to promote individual accountability in teams as well as require students to learn more about different aspects of their team project. An added benefit is that students gain additional project management skills.

Purpose of the Team Work Breakdown

The purpose of the TWB is twofold: encourage individual accountability as well as encourage integrated learning across the team project.

One of the difficulties of using team work in the engineering classroom is avoiding situations where one student carries the team or one person skates on the coattails of their team members. Originally, a peer assessment process, which was part of the final portfolio, was used to encourage individual accountability. But the instructor found two problems with the peer assessment submission as a part of end of term portfolio. Firstly, the instructor received the peer evaluation at the end of the term, so the document could not be used in a formative way to encourage students to improve team work practices. It should be noted that most students are hesitant to inform the instructor about the poor performance of their team members during the term because they are afraid of losing the member or worsening their team relationships. Secondly, when conflicts or difficulties were identified at the end of the term via the peer assessment process, the instructor had difficulty identifying sufficient evidence to know if a student really had not contributed properly.

One of the difficulties students have compiling their final portfolios is determining which parts of the team project can be submitted as evidence of their individual learning. Similarly, from an instructor's prospective, it is difficult to evaluate how valid a student's claim is of a particular team contribution, especially when there are conflicting reports amongst students.

Another difficulty that was identified by the instructor in the end term interviews was that students usually were very informed only about the aspect of the project they had been most responsible for. Students' typical practice was to divide the entire project in different tasks and assign those tasks to different individuals. They each put their effort into completing their

own tasks with their maximum capacity to ensure their part of the project was of highest quality. This project management approach could stem from the fact that students could use team project outcomes as evidence of achievement of the learning outcomes in the final portfolio. Thus, good project outcomes became the main focus of the team efforts, but not individual leaning outcomes. Hence students cared more about the final project results and report than they do their own individual learning. So at the end of the semester students usually could not speak to other aspects of the project. In addition, they had the attitude that they were not responsible to know about other aspects, as they were not the lead on those aspects.

The development of the Team Work Breakdown attempts to address these identified difficulties.

Method: Using Action Research to develop the Team Work Breakdown tool

The instructor used the AR cycle to develop the TWB tool to better promote individual accountability in a team setting and to better motivate students to learn about all aspects of the group project. The TWB tool was initially adopted in 3rd year Water and Environmental Design course in 2012. There were 18 students and they were divided in 5 different teams of 3 to 5 students. Four of the teams consisted of all on-campus students and one team was created with all distance students. The TWB is also part of the 2013 offering of the 3rd year Water and Environmental Design of 23 students on 6 teams [3 on-campus teams and 3 distance teams]. An example of the TWB tool is in Appendix 1.

TWB is introduced to the students in the first day of the course (Appendix 1) and they are required to use it with all group projects. Once student project teams are assigned, the students complete the TWB given the following requirements:

- The proportion of the workload should be fairly equally distributed amongst the team members. The example distribution of work between 4 students shown in Appendix 1 is acceptable.
- Each task must have a Task Leader
- Tasks must be broken down into subtasks. Each subtask must only address one course learning outcome.
- Each student is responsible for the tasks they are leading as well as contribute to tasks in which they are not the Task Leader.

Each team must show the first draft of the TWB to the instructor before commencing project work. To prepare the TWB, students need a fair understanding of the project scope. Once they gain that understanding, students then divide the entire project in different tasks at a coarse scale. After this step, students assign the workloads of each individual task. The instructor provides some formative feedback to the students to refine their projected tasks and estimates of the workload of such tasks because the students are usually inexperienced with project scope management and project time management.

Once the workload of each task is agreed upon by all the team members, the students assign a Task Leader for each task. Then each Task Leader individually researches his or her tasks in more detail and then proposes further subdivision of the tasks so that each task only covers one course learning outcome. This further subdivision provides a means to allocate the work to individual members. Students can be strategic in selecting tasks, as they may use the project tasks as evidence of achievement of different course learning outcomes when preparing their final portfolio.

In the 2012, once the workload on each task was determined, students were not allowed to update the TWD. Using the AR cycle to reflect on the first implementation of TWD, the instructor decided to change the implementation. The instructor determined that it would be in students' best interest to revisit the workload as they progress because such revisions will

make the TWD tool more useful to the students and possibly increase team engagement. Often students' initial estimate of the level of time and effort for each task needs to be changed as student work progresses. These changes may be driven by the direction of the project, availability of data or the team members' prior knowledge and experience with the subject matter.

In the 2013 implementation, students were allowed to update the TWD as needed throughout the project duration. Students must communicate and negotiate why the stipulated workload has to be changed and adjusted with their teammates and the course instructor.

As before, students submit their portfolio at the end of the semester presenting evidence of achievement of each of the required course learning outcomes. Students can refer to their own TWD tasks as evidence of achieving a learning outcome. Students cannot refer to project tasks that they did not complete as evidence for their learning outcomes. The effectiveness of this approach is measured through instructor observations and reflections as reported below.

Results & Discussion

The TWB tool was first introduced in 2012 offering of the PBL Water and Environmental Design course and then again in 2013. There were two required team projects and the final course assessment is the portfolio described above. This section presents results from instructor observations and reflections on how individual accountability and integrated learning was improved after implementing the TWB those two instances. Each section will be organized by reporting instructor reflections *before* using the TWB and *after* using the TWB.

Individual Accountability

Before Using the TWB: Before the TWB was introduced, individual accountability was formally assessed via the required end of the term peer assessment which students submitted as a part of the portfolio. This method was difficult for the instructor to use. There was a lack of transparency because students could not see what others wrote, so members from non performing teams were likely to write conflicting information about each other. In such cases, it was difficult for the instructor to use the peer assessment information to identify individual contributions to the project and thereby identify "skaters" or "over achievers". Such situations cause much frustration for both students and instructors.

Another difficulty was that the end of term peer assessments could not be used in a formative way to help improve team dynamics over the term, or help the individual students improve past the end of the term, as students do not receive feedback from their peers. The TWB may help students negotiate difficult team management issues.

After Using the TWB: The quality of the student reports was improved in the 2012 over previous semesters. The 2013 student reports have not yet been graded, so those results are not reported here. The 2013 improvement may be due to the increased positive interdependence and individual accountability (Smith et al. 2005) that the TWB provides. Cooperative learning theory tells us that positive interdependence and individual accountability will improve learning (Smith et al. 2005). However, as discussed in the limitations section, this improvement may just be due to the variation observed in different classes.

The TWB may help students negotiate difficult team management issues. In the 2012 offering of the course, the instructor was unaware of any negative team dynamic issues. In the 2013 offering of the course, the instructor learned of one team using the TWB to motivate a recalcitrant student to increase participation. The other three members of the team let the student and instructor know that they were planning to change the recalcitrant student's TWB contribution to zero percent. The student then started showing up to class and meetings. The student finally did contribute a less than fair share to the first project, but promised (and

delivered) a fair share to his next team project. In this case, students were able to use the TWB to manage the project and confront a non-performing student during the project in hopes of improving the final outcome.

Students can find it challenging to identify appropriate evidence for learning outcomes in PBL courses. Students now use the TWB to easily to refer individual project tasks as an evidence of one of their individual learning outcomes. This approach saves them time when developing their final portfolios.

Another observation that points to increased individual accountability is that students are advised that they need to contribute a fair share to each project, but the instructor does not prescribe an upper or lower limit of what is "fair". However, the observed difference between the member contributions in a team has been within ±5% of each other, which is appropriate and confirms the accountability of all team members.

The TWB improved individual accountability in the course. The TWB is a transparent process in that it can evolve over the project and should reflect the actual workload as agreed upon by all team members. The TWB acts as a team negotiated contract that the students and instructor have access to at all times.

Integrated Learning

Before Using the TWB: Without the structure of the TWB, students divided the project into a number of tasks, distributed the tasks among the members and worked on their own tasks with minimal interaction in an effort to be efficient with their time (but not as effective with their learning). When the students managed themselves this way, most of them only learned about a specific aspect of the project. (However, there are a *few* self-motivated students that chose to learn about the entire project). The instructor observed during the end of term portfolio interview some students were unable to answer questions about multiple aspects of the project. The students also had the attitude that they were not expected to know much about multiple aspects of the project.

After Using the TWB: All students now come to the portfolio interview with the expectation that they will be required to discuss multiple aspects of the project. The instructor has observed that students are able to speak to multiple aspects of the project as documented in their TWB. Students also have an easier time presenting evidence of how they meet each course learning outcome, as the tasks outlined in the TWB are aligned with course learning outcomes.

The TWB requires all the team members to understand multiple aspects of the project. In addition, the TWB encouraged students to understand their project scope earlier in the project. This deeper understanding of the project at the early phases helps students complete their tasks more easily. As the TWB can be updated regularly, communication between the students on the different tasks is likely to be more frequent than when the TWB was not used.

Limitations

Some students find the TWB is as an extra workload. However, teams with one (or more) nonfunctional member(s) find the TWB a mechanism to encourage everyone to contribute.

More instructor time is required during the term when using the TWB as the instructor is required to regularly check the updated TWBs so that no disagreement arises towards the end of the project.

In any study comparing one group of students to another, there is inherent variability. Thus, all observations comparing course cohorts should be considered in that light.

Conclusions

The implementation of the TWB has improved the scope of student contributions to group projects, thereby improving the breadth of topics students learn. In addition, the TWB provides a mechanism to promote individual accountability to the point that students in third year courses are no longer required to submit a peer assessment. Students are able to more clearly document their individual contributions to the project and how those contributions are aligned with required learning outcomes. Lastly, the Task Work Breakdown helps students further develop important project management skills of project scope management and project time management. Another teaching team at CQU is choosing to adopt the TWB in their PBL course because they believe it will help improve student learning.

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Copyright statement

Appendix 1

Team Work Breakdown **Mini-Project1: Water balance calculation over a large geographic domain**

Task	Tasks / Subtasks	Learning Outcome #	Task Leader	% of Work Load to be agreed before allocating Task leaders	Students to complete this section after completion of the work. Values given are indicative only.			
					Member A	Member B	Member C	Member D
1.0	**Calculation of Effective Precipitation**	**1,10**	**Member A**	**25**				
1.1	Acquire standard PPT data	1		5	3	-	2	-
1.2	Obtain and prepare Catchment map	1		5	3	2		
1.3	Calculate mean Areal	1		10	2			8
1.4	Calculate final effective PPT	1		5	2	3		
2.0	**Calculation of Actual Evaporation**	**1,10**	**Member B**	**20**				
2.1	Obtain Potential ETO data	1		10	2	5	3	
2.2	Calculate Actual ETO	1		5		2	3	
2.3	Calculate average ETO	1		5		2		3
3.0	**Calculation of runoff**	**1,10**	**Member C**	**15**				
3.1	Obtain related river flow data	1		5			5	
3.2	Calculate Catchment area	1		5		2	3	
3.3	Calculate runoff	1		5	2		3	
4.0	**Water balance analysis**	**1,10**	**Member D**	**30**				
4.1	Prepare a water balance analysis sheet	1		20	5		5	10
4.2	Present the calculations	10		10		5		5
5.0	**Team Leadership and compilation of the reports**	**9,10**	**Member A**	**10**				
5.1	Team work and management	9		5	2	1	1	1
5.2	Write a report	10		5	2	1	1	1
			Total	**100**	**23**	**23**	**26**	**28**

Notes: Prepare subtasks in such a way that they can be strongly linked to only one aspect of a learning outcome. Task leader should allow and encourage other members to contribute to the task. It is an individual member's responsibility to make their fair share (close to equal) of contribution in the project.