Effecting Teamwork Outcomes in Online Courses

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BACKGROUND
Teamwork is a critical graduate attribute for engineers, so universities formally incorporate such activities into individual courses in their degree programmes. Because conditions for effective teamwork relate to interpersonal variables such as positive interdependence and promotive interaction (Felder, Woods, Stice, & Rugarcia, 2000), the affordances of team-based learning activities can be diminished in online environments, where the immediacy of interaction can be lost (Fisher, Phelps, & Ellis, 2000). What is unknown is what occurs in the operation of teams that can make them work well or cause them to fail.

PURPOSE
The objective was to discover what practices occurred in teams that had direct interaction and how they differed to teams which relied on the internet for contact.

DESIGN/METHOD
A critical realist approach was used to examine data from student reflections on how their groups functioned during a semester of study in a project-based engineering course. The reflections were analysed using the CMO framework of Pawson and Tilley (1997), in which contexts (C) and mechanisms (M) interact to produce outcomes (O). Contexts are the "spatial and institutional locations of social situations, together with the norms, values, and interrelationships found within them" (Pawson & Tilley, 1997). Mechanisms "refer to the choices and capacities which lead to regular patterns of social behaviour" (Pawson & Tilley, 1997).

RESULTS
Positive outcomes were only produced when a positive mechanism was implemented. A positive mechanism could be implemented in response to a positive or negative context, but negative mechanisms were only implemented in response to a negative context. Sometimes, removing a negative context can result in another negative context being created.

CONCLUSIONS
The most effective action to overcome a negative context could be to support the introduction of a positive mechanism, since removing the negative context can have unforeseen side-effects of introducing another negative context which requires managing. The effect of distance between team members was not found to be an over-riding context that requires removal, since a number of other negative contexts can be encountered irrespective of how close team members are to each other.

KEYWORDS
Group work, Student interactions, Student outcomes.

Introduction

Teamwork is a critical engineering graduate attribute (Dowling, Carew, & Hadgraft, 2010); in order to prepare their students, universities have formally introduced courses and programmes that incorporate teamwork (Du & Kolmos, 2009; Gibbings, Lidstone, & Bruce, 2010; Said, Adikan, Mekhilef, & Rahim, 2005). Students who take such courses via distance-education (external) mode face different challenges because the types of interpersonal interactions that occur online are different to those encountered face-to-face (Crossman & Bordia, 2011). Specifically, conditions for effective teamwork relate to interpersonal variables such as positive interdependence and promotive interaction (Felder et al., 2000). As a consequence, the benefits of team-based learning activities can be diminished in online environments because of this loss of immediacy in the inter-personal interactions (Fisher et al., 2000).

The question that remains unanswered from this issue is whether being able to interact face-to-face is "better" than never being able to interact face-to-face. In the business world, a study found that to achieve good cooperation, it was necessary to have: a strong set of goals, physical proximity (defined as the "perception" of closeness, rather than distance between locations) and well-defined team rules and procedures (Pinto, Pinto, & Prescott, 1993). Another business study (McDonough, Kahn, & Barczak, 2001) defined three types of groups: collocated (in the same location and culturally similar), virtual and global (culturally and geographically diverse). Behavioural challenges were found to be greatest in global teams and least in collocated teams, while management challenges for virtual and global teams were similar but greater than those for collocated teams. The performance (defined to be the quality of delivery of the client's needs in a timely fashion) of global teams was substantially worse than virtual teams, with collocated teams performing best. The behavioural challenges that were encountered did not result in a particular performance level for any group, while management challenges did. Because management challenges impacted all groups' performances to a similar extent, it appears that improving the management of the team is the most fruitful technique to improve performance, although this may not equalise the performances between types of group.

In the classroom, Yang and Jin (2008) compared a master's-level course (with teams containing both on-campus and distance students) to an undergraduate course (with only on-campus students). The collocated teams tended to be more socially-oriented, particularly within self-selected teams, and this can hinder performance by losing focus on the task. However, distributed teams tended to be more task-oriented because of the diminished opportunity to meet face-to-face, particularly for those teams with significant distance between members. Another study (Gibbings & Brodie, 2008) found that some social interaction did occur amongst external students in the first course of the degree programme, which resulted in effective learning communities. Gapp and Fisher (2012) allowed teams of final-year business students to meet face-to-face to define team structures before the teams could only meet virtually. This was the first time these students had been involved in online team interactions, so those teams that used the initial meeting effectively greatly enhanced their performance.

The current work seeks to address this issue by studying a course where the on-campus ("internal") and distance-education ("external") students were segregated in the team-formation process. Some of the external teams were formed so that students were easily able to meet face-to-face (and are therefore equivalent to the internal teams), while the remaining teams were formed so all members were in the same time-zone (where possible) or randomly. The grades as a measure of performance are not studied in this paper; rather, it is the students' perceptions on how successfully their team functioned. While student satisfaction may increase with increasing grades, there is not necessarily a strong correlation between the two.

The Current Study

The third in a series of courses utilising teamwork is studied. Typically, 60–70% of enrolments in this second-year engineering course are external students. The external students nominated a geographical location where they would be studying for the majority of the semester, noting fellow students they would like to be in the same team. The teaching team then allocated students into teams based on this information. The external teams can be segregated into "collocated" (living within one-hour's drive from all other members), "distributed" (in the same time-zone) and "random". The collocated teams can be considered to be equivalent to the internal teams in terms of the opportunity to meet face-to-face, although the frequency of such meetings is lower (Wandel & Willey, 2012), which is largely a consequence of the external students organising meetings around their full-time work and family commitments. This work focusses on the 2013 offering of the course, where there were 18 collocated teams, 7 distributed teams, 9 random teams and 20 on-campus teams.

For the team assignment, groups were required to submit an intermediate report (worth 7.5% of the assignment), with the major report due at the end of semester. Following the submission of the final report (and before the marks were released), students were required to submit an individual reflection (worth 12.5% of the assignment) up to one page in length "describing challenges you and your team encountered and what steps you took to overcome these challenges. These challenges can cover every aspect of your team project, such as: group dynamics, MATLAB issues, report writing, background research." The students were also supplied a marking rubric for this reflection (Table 1).

Table 1: Marking rubric for individual reflection.

Is there a thorough description of what challenges were faced and a detailed understanding of how these challenges were overcome?	= 50 marks
Is there a good description of the majority of challenges that were faced and a good understanding of how these challenges were overcome?	= 40 marks
A large number of challenges were described, but little detail of how they were overcome or there were a small number of challenges described reasonably well.	= 30 marks
A small number of challenges and/or weak understanding of how they were overcome.	= 20 marks
Very few challenges and/or a poor understanding of how they were overcome.	= 10 marks

This reflection forms the basis for the current study. Because the marks were awarded based on the quality of description (rather than writing what the assessor wanted to hear) and the students were restricted to one page (eliminating spurious difficulties just to fill space thereby focussing the writing on the most important issues), these reflections produced largely unbiased descriptions of the teamwork. The methodology used to analyse the reflections assisted in avoiding any remaining bias.

Methodology

A critical realist approach was used to examine the data from the student reflections. The reflections were analysed using the CMO framework of Pawson and Tilley (1997), in which contexts (C) and mechanisms (M) interact to produce outcomes (O). Contexts are the "spatial and institutional locations of social situations, together with the norms, values, and interrelationships found within them" (Pawson & Tilley, 1997, p. 216). Mechanisms "refer to the choices and capacities which lead to regular patterns of social behaviour" (Pawson &

Tilley, 1997, p. 216). By using Realist Evaluation methods to conduct the analysis, underlying bias created by using assessable items could be minimised.

The relevant contextual variables that were extracted included:

- how team members could access one another (face-to-face, synchronously, or asynchronously);
- the level of familiarity they had with one another (such as through previous study or work), and;
- barriers to communication (such as lack of a common language or lack of access to reliable technology and internet).

The significant mechanisms that arose from analysis were:

- how the students chose to approach the group-based task (such as actively working to 'get on the same page' or making use of each other's strengths and weaknesses);
- how they chose to manage the team processes (such as the degree of formality or informality with which the team was run), and;
- how they planned to manage any communication barriers (such as combining synchronous and asynchronous modes of communication).

A total of 216 separate reflections were collected for analysis. These documents were imported into NVivo and grouped according to the team number for each student. This meant that for each team, there were a number of sources of data to analyse (2–5 reflections per team), and so patterns of team functioning could be triangulated on a team-by-team basis. When conducting the analysis, the geographical distribution of each team was noted. Furthermore, it was noted which teams were made up of members who were co-workers at the same workplace and whether teams could communicate synchronously or only asynchronously. These were found to be important factors in the outcomes that the teams were able to achieve.

Once all of the sources had been uploaded into NVivo and coded according to which team number they belonged to and the location characteristics of that team, constant comparative analysis was undertaken to reveal patterns in the comments about teamwork that students were making. Initially, these categories of comments were simply created as nodes, and every time a comment recurred that fit within a category, the relevant excerpt from the source in question was simply coded to that node. This process was repeated until saturation of the data was achieved, in that no new nodes were being created.

Having coded the sources to saturation to each of these nodes another stage of analysis began in which the principles of Realist Evaluation (Pawson & Tilley, 1997) were applied. Each node was analysed according to whether it functioned as a context (C), a mechanism (M) or an outcome (O) in the teamwork process. Contexts are defined in terms of the sociocultural conditions that a program operates within, whereas mechanisms are understood to be the choices people make as a result of a program (Pawson & Tilley, 1997). By examining how patterns of Context and Mechanism occur in configuration with particular Outcomes, it is possible to propose how generative causation occurs among the variables for a particular program (in this case, how the locations of the team members affect teamwork processes). With this theoretical approach in mind, analysis of existing nodes was then undertaken to interpret if each was functioning as a context, a mechanism or an outcome.

Once the function of each of these nodes had been established [in accordance with the Realist Evaluation definitions by Pawson and Tilley (1997)], this allowed the data to be analysed in a third phase to establish patterns of CMO configurations. This approach is based on the premise that aspects of context trigger particular mechanisms in response, which in turn result in observable patterns of outcomes. This is often expressed as the formula C + M = O (Pawson & Tilley, 1997).

To achieve this with the current data set, queries were run and a spreadsheet created to establish the patterns of Cs, Ms and Os that were apparent in the coding of data. In other words, it was possible to trace which mechanisms tended to occur in the same sources as particular contextual variables, and if the outcomes that went with these patterns were positive or negative.

Results

The nodes that were identified in the coding process, with their allocation to a function, are listed in Table 2. The contexts show circumstances which the teams faced. Examples of communication barriers were being in different time-zones, having a member with English as a Second Language (ESL) or difficulties with the technology used for communication. The mechanisms show different ways in which teams responded to contexts that they encountered. The outcomes show what conclusions the individuals drew from the experiences in the team activity.

Table 2: Classification of nodes according to function.

Node type	Nodes
Contexts	• Communication barrier • Schedule conflicts • Already knew one another • Nominated team roles • No prior experience (with an aspect of the course) • Significant prior experience (with aspects of the course) • Similar experience or attitude to group task
Mechanisms	• Becoming informal in the team • Formalising team processes • Complementing each other's strengths • Getting on the same page • Working against one another • Working separately • Finding an asynchronous workaround • Focussing on being adaptable
Outcomes	• Value in doing work as a group • Problems caused by doing work as a group

By looking at the variables of Cs, Ms and Os with their correlation it was possible to determine what effect a given variable had on creating outcomes for teamwork functioning in the course. For instance, it could be deduced whether a given contextual variable elicited positive (supporting) mechanisms that in turn created positive outcomes. Often, what were seemingly negative (inhibiting) contexts actually acted to trigger positive mechanisms which resulted in positive teamwork outcomes. The CMO configurations that were obtained in the current study are presented in Table 3. Blue cells indicate a positive node, while red cells indicate a negative node. There are a number of positive (enabling) contexts and also negative (disabling) contexts. Where there was a positive context, the students always implemented supporting (positive) mechanisms, which resulted in a positive outcome. However, for the disabling contexts, some mechanisms that were implemented were positive and others negative.

Table 3: CMO configurations from the nodes in Table 2.

Contexts		Associated Mechanisms		Associated Outcomes
Enabling	**Disabling**	**Supporting**	**Inhibiting**	
	Communication barrier	Getting on the same page		Positive
		Finding an asynchronous workaround		
			Working against one another	Negative
			Working Separately	
	Schedule conflicts	Finding an asynchronous workaround		Positive
			Working separately	Negative
	Already knew one another		Becoming informal within the team	Negative
Nominated team roles		Formalising team processes		Positive
		Complementing each other's strengths		
	No prior experience	Formalising team processes		Positive
		Getting on the same page		
Significant prior experience		Complementing each other's strengths		Positive
Similar experience or attitude to the group task		Getting on the same page		Positive
		Complementing each other's strengths and weaknesses		

The important conclusion to be drawn is that whether the outcome was positive or negative correlates to the mechanism that was implemented in response to the context, so a supporting mechanism is able to overcome a disabling context to produce a positive outcome. Because an enabling context produced a supporting mechanism, each of these

contexts produced a positive outcome, so conceivably removing a disabling context is beneficial to the team.

This important finding was supported by further analysis which compared the location characteristics of the teams against these CMO configurations. It was found that the variable of location did not have a significant effect on positive or negative outcomes, because the contexts and mechanisms that were uncovered in the data analysis could be present for either distributed or collocated teams. Further, positive and negative outcomes were distributed fairly evenly across distributed and collocated teams.

A key point that should be noted is that removal of a disabling context is not a guarantee of producing a positive outcome, because it can introduce another disabling context. For instance, for the two teams where the members worked in the same workplace, removing the "Communication barrier" disabling context introduced the "Already knew one another" disabling context. This is because the familiarity with team members, and the pre-existing roles from the workplace tended to lead to informality in team processes and communication, an inability to make use of each other's strengths and weaknesses, and a tendency to work against one another somewhat. This was not true of on-campus teams who had worked together before in a learning environment. This finding, although for a very small selection of participants, suggests that this would not be a productive context for teamwork, or direction would need to be given to ensure that a supporting mechanism was implemented.

Conclusions

A study has been performed to ascertain the influence of the geographical distance between team members on the individual's perception of the outcome of the teamwork. Specifically, the operation of the teams has been investigated to discover how these differences influence the outcomes. The outcome was defined based on students' perceptions of the teamwork after submitting the final report, but before receiving the marks. To analyse the data, a Realist Evaluation was performed, identifying Contexts that the students encountered, Mechanisms that were implemented in response to Contexts and Outcomes that were produced.

It was found that having an enabling (positive) context led to supporting (positive) mechanisms being implemented with a corresponding positive outcome. Where a disabling (negative) context was encountered, if a supporting mechanism was implemented, then a positive outcome resulted; however, if an inhibiting (negative) mechanism was implemented, then a negative outcome resulted.

It can be concluded that creating enabling contexts (equivalently, removing disabling contexts) for students results in a positive team experience. Where disabling contexts cannot be removed, they can be overcome through appropriate management strategies. Caution must be noted that removing a disabling context could introduce another, unforeseen disabling context, so it is appealing to treat the known problem effectively.

The issue of distance between members of a team is not necessarily a context that should be of major concern, because it is only one possible disabling context that can occur. A number of other disabling contexts were found in collocated teams which resulted in negative outcomes. Indeed, it encouraged students to respond in positive ways to challenges such as schedule conflicts and communication barriers, for instance, by formalising team processes, actively working to get on the same page, working to complement each other's strengths, and finding asynchronous workarounds for group tasks. Importantly, the issue of distance between members was not identified as a node in the coding process, so it is not the separation which is a difficulty *per se*, but other problems such as communication barriers which could be created as a consequence. This could be due to students having experienced the same situation in the two prior courses, with the consequential development of proven supporting mechanisms (Wandel, 2011). Because student satisfaction (what was measured) does not solely depend on marks, it is possible to draw a different conclusion to

previous studies based solely on marks (Wandel, 2011); further study is required to attempt to correlate these effects.

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