

# Investigating the characteristics of successful collaborative learning activities

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***Abstract:** Given that engineering is a practice-based profession, one of the benefits of collaborative learning is that it provides the opportunity to simulate this practice within classroom activities. While not replacing the benefits of actual practice, thoughtfully designed collaborative learning activities provide opportunities for students to construct and test their knowledge while developing their professional judgement. Hence, it is important to identify the common characteristics of collaborative activities that improve student learning. Based on the results of our research we hypothesised that with the correct scaffolding, activities that include integrated collaborative conversations improved the learning within small group activities. In this paper we report the first step in a research project to determine the characteristics of successful collaborative learning activities that include integrated peer conversations to assist academics in designing their own successful collaborative activities. To test our hypothesis we first examined a series of studies that report the effect of collaborative activity on student learning to identify any common characteristics that seemed to have a positive impact.*

## Context/Background

In 2000 Johnson, Johnson & Stanne published their meta-analysis of 164 studies comparing the effectiveness of eight different collaborative learning activities to individualistic and competitive learning methods. They found that "...if cooperative learning is implemented effectively, the likelihood of positive results is quite high. Results, however, are not guaranteed."(Johnson, Johnson, & Slanne, 2000)p.16). Since 2000, published studies in discipline areas as diverse as engineering, business, law and medicine, have reported on the use of collaborative learning activities in the higher education sector. While some studies claim that these activities increase student learning (Dana, 2007; Koppenhaver & Shrader, 2003; Lisk, 2003; Stark, 2006); studies by others report no significant improvement in learning when using collaborative activities compared to the traditional lecture method (Haidet, Morgan, O'Malley, Moran, & Richards, 2004; Lancaster & Strand, 2001; Lucas, Baker, & Roach, 2001).

## Research Questions

Given that engineering is a practice-based profession, collaborative learning provides the opportunity to simulate this practice within classroom activities. While not replacing the benefits of actual practice, thoughtfully designed collaborative learning provides opportunities for students to construct and test their knowledge while building their professional judgement (Billett, 2006). Hence, it is important to identify the common characteristics of collaborative activities that improve student learning. We hypothesised that some of the differences reported by (Johnson, et al., 2000) were probably due to a number of factors including implicit variations that were not the focus of these published studies, for example how well the activities aligned with both the learning outcomes and assessment of the courses. Furthermore, in our research, in agreement with (Lucas, et al., 2001), we have found that embedding peer conversations in the course design enhanced the learning within collaborative activities.

Embedding conversations in the course involves academics having a more systems approach to instructional design, rather than seeing the group activities as a 'bolt – on' to existing practices. Our experience suggests the following sequence of activities: individual pre-discussion work, in class/meeting small group discussion, individual re-test, in class/meeting small group discussion involving more complex problems or the same concepts in a different context.

Individual pre-discussion work by the students appears to make the conversations more effective. Furthermore, our experience shows that more than one iteration of individual activity followed by peer discussion improves the learning outcomes for most participants (Willey & Gardner, 2011). This could be, for example, having students test their individual knowledge after the first discussion and then having groups collaborate on solving a problem in a slightly different context or at a higher level of complexity than the initial problem.

Aspects of the overall course context such as the assessment scheme and whether the academic explains their instruction design also affect students' participation and benefits gained from collaborative activities. In our research we found that the formative nature of the activities allowed students to focus on learning the material rather than strategically trying to maximise their marks. An instructor explaining why the students are working in groups and how they should be approaching their group activity in terms of their own learning also seems to help students learn from their peers.

As part of the initial stages of a systematic investigation of whether these characteristics have a positive impact on student learning in collaborative activities that include peer conversations, we examined a range of studies that report both improvements in learning and no significant difference compared to non-collaborative activities.

## **Theoretical Framework**

All the studies in this review investigated methods of collaborative learning that included conversation/discussion between students as a part of the process. From a social constructivist perspective the inclusion of conversations between students, and between students and the instructor, is the essential component in the process, as it is through these conversations that students (& academics) renegotiate their concepts of a topic to come to a shared understanding. (Nicol & Boyle, 2003) found "Students reported that peer discussion resulted in their reconceptualising important principles as well as learning about new methods and approaches to problem-solving."

## **Method**

We define a collaborative learning activity to be one where there is purposeful interaction between two or more students, and we restrict our analysis to examining the quality of the learning reportedly achieved, usually by test scores or course grades, but sometimes additionally by students' perceptions. The reported studies claim a range of success with a collaborative learning method, but broadly speaking we identified eight that concluded that compared to the traditional lecture method collaborative learning led to significantly 'better' learning (positive studies) and five which did not. The five that did not still found that learning occurred, but that this learning was not significantly better than that achieved using lectures. We denoted these studies as being neutral.

Our investigation was limited to published studies that focus on collaborative learning activities in courses in the higher education sector where students and instructors interact face-to-face (>50% of the time in class). This synthesis includes quantitative, qualitative or mixed methods research and evaluation studies that have been published in English in refereed journals or conference proceedings since 2000. Studies with no theoretical framework or which were judged to have a poor evaluation method were not included.

In comparing the reported outcomes in these papers we considered the following factors:

- Whether there was individual work to be completed before student discussion occurred (pre-work),
- Where the student discussion occurred (eg. in class or out of class),
- Whether the reported activity was summative or formative, and

- Whether the instructors explained the reasons for using the collaborative learning method to the students involved in the study.

## Findings

All studies investigated student learning in the higher education sector, except for Haidet et al (2004) who looked at medical residents. While there are several characteristics that can be compared across these studies, a summary of the main aspects pertinent to our interest are listed in Table 1 to assist comparison.

The size of the groups in these studies ranged from 3 to 7 with most instructors targeting 4 as the ideal group size. In the educational literature these would be classed as small groups. Nicol & Boyle (2003) compare two published collaborative learning methods (peer instruction vs. class-wide discussion). Although group size was not the only difference between these two methods it was a significant variable and students felt that the small group discussion was more effective than the class-wide discussion method.

### Individual pre-discussion work required

In the study reported in this paper most of the collaborative learning processes with significant positive benefits required students to answer some relevant questions individually before the group discussion occurred. However, three of the eight did not report whether individual pre-discussion work was required or not. Amongst the neutral studies three of the five required individual pre-discussion work, one did not and one did not report whether it was required or not. So while most studies seem to suggest individual pre-discussion work is useful, it is not the only factor contributing to the success of the activity since some neutral studies included it too.

The other significant variable between the two peer learning methods reported by Nicol & Boyle (2003), apart from the group size as discussed above, is that with the peer instruction method students were required to answer the problems individually before engaging in discussion with their group members about which was the correct answer and why. They found that: "Almost all the students interviewed expressed a preference for starting the concept test with individual thinking and an individual response, rather than with peer discussion. They were forced to think about the problem, and to formulate their own reason for their selected answer before the group discussion. Having constructed their own answer students felt they benefited more from the subsequent peer discussion."

Haller et al (2000) suggest a reason why getting students to individually attempt questions before the discussion can help the group function. They analysed the conversation of four groups as they solved group homework problems and identified two types of conversation sequences: transfer of knowledge sequence (teacher/pupil relationship) and the collaborative sequence (shared thinking out loud to achieve joint understanding). Furthermore they found that interaction patterns referred to as 'constant pupil' and the 'blocker' tended to interfere with group function. In the constant pupil interaction the same group member needs to have concepts explained by other members of the group which can lead to these members feeling slowed down or that the constant pupil is not pulling their weight. From this research these authors recommend that students should attempt the homework problems alone before the group meeting as this would minimise the constant pupil type of interaction.

### Formative or summative activity

Ramsden (1992) tells us that students experience our courses through the assessment tasks and allocate their time depending on what activities will earn them marks. Academics have often interpreted this as meaning they have to allocate marks to an activity to get students to do it and that the marks allocated reflect the value of the learning we expect students to get out of that activity.

**Table 1: Selected characteristics of published studies of collaborative learning activities**

Author	Purpose of study	Individual pre-work?	Peer discussion in class?	Formative or summative?	Learning method explained?
Positive Studies					
Dana (2007)	TBL versus non-TBL learning format	Yes	Yes	summative	Yes
Nicol & Boyle (2003)	peer instruction vs class-wide discussion	Yes for peer instruction. No for class-wide discussion.	Both in & out of class	formative	Yes
Koppenhaveer & Shrader (2003)	empirical model of team performance tested	Not reported	Both in & out of class	Summative	Not reported
Lisk (2003)	team mark vs stages of team development	Not reported	Yes	summative	Not reported
Stark (2006)	Benefits of team exams	Yes	Yes	Summative	Not reported
Haberyan (2007)	lecture vs TBL format	Yes	Yes	Summative	Not reported
Willey & Gardner (2011)	Collaborative vs lecture format	Yes	Yes	formative	Yes
Haller et al. (2000)	Dialogue of 4 student teams analysed	Not reported	Both in & out of class	summative	Not reported
Neutral Studies					
Haidet et al (2004)	Active & collaborative vs lecture format	Yes	Yes	formative	Not reported
Ellis, et al. (2008)	conceptions of learning vs course mark	Not reported	Yes	summative	Not reported
Lancaster & Strand (2001)	lecture vs TBL format	Yes	Yes	Summative	Not reported
Lucas et al (2001)	lecture vs team learning groups	Yes	Yes	Summative then formative	Not reported
Kittleston & Southerland (2004)	engineering Discourse to describe how students worked in a group	No	In labs & out of class	Summative	Not reported

Of the eight studies that reported significant learning in collaborative activities, two (Nicol & Boyle, 2003; Willey & Gardner, 2011) used formative group learning activities and one (Dana, 2007) used a combination of both summative and formative activities. The reasons that most activities in the study used summative assessment are unclear. There was no way of distinguishing if summative was chosen as a matter of course as it is what's typically done, or because the instructors believed that activities needed to be summative for students to engage with them. After our success with formative activities, we suggest that the collaborative learning activities themselves do not necessarily have to be summative, however engagement will be reduced if the learning resulting from the formative activities does not significantly and efficiently help students prepare for their eventual summative assessment.

### **Learning method explained to students**

Of the eight positive studies, three (Dana, 2007; Nicol & Boyle, 2003; Willey & Gardner, 2011) report that students were given an explanation and justification of the use of the collaborative learning method used by the instructor. Amongst the neutral studies only Lancaster and Strand (2001) explain how and why team learning was being used to their treatment group who were using team-based learning.

In the neutral study by Ellis et al (2008) however, they conclude that "... it is clear that many students do not necessarily see how to approach discussions... in ways that promote understanding. Setting discussion tasks without helping students see the potential benefits are...unlikely to lead to good learning outcomes."(p.280) This suggests that participant performance in collaborative activities improved with understanding of both the learning method and objectives. We suggest that such explanations provide a metacognitive framework to help participants obtain the full benefit from a collaborative learning activity.

### **Future research plans**

This analysis, although constrained to fit in the page limit for the conference, is the first step in designing a research study to investigate the requirements for improved learning outcomes in collaborative activities with integrated peer conversations. In particular, we will investigate:

- How individual pre-work completed before class/meeting makes a significant difference to the effectiveness of the subsequent conversations for learning,
- How making the collaborative activity summative or formative changes the behaviour and/or engagement of the participants and whether this has an effect on their learning,
- Whether explaining the reasons for & the theory behind the group learning method makes a significant difference to how well participants perform in subsequent individual assessment activities testing higher order thinking skills, and if so determine some of the contributing factors, and
- The effect of including an individual activity after the discussion to allow students to reassess their learning gaps.

An evaluative framework that is proposed for this future research is the Learning Variables framework used by Lucas et al.(2001). One of the most significant variations they found between a collaborative activity and a traditional lecture method relates to the variable labelled 'rehearsal'. Rehearsal relates to the process of reviewing information. They distinguish between two types of rehearsal, maintenance rehearsal which is simply repeating information in rote fashion, and elaborative rehearsal which integrates new information with old information. Peer learning activities create opportunities for focussed discussion which supports "...elaborative rehearsal, a process important for developing meaning and transferring information from short to long-term memory" (p.74). This appears to be a useful concept for modelling the conversations that take place in collaborative learning activities and for indicating impacts of the characteristics of interest listed above.

### **Conclusions**

Examination of thirteen selected studies suggests that learning outcomes in small groups can be improved if participants are required to answer some relevant questions individually before the group

discussion occurs, and if the learning method is explained to participants before they start. While most studies used summative assessment of collaborative activities, this was not a requirement for success and the purposeful integrated design of a whole course is likely to be more important than whether a particular activity is summative or formative.

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