Interdisciplinary group work in higher education: A student perspective

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This research intends to provide understanding of the impact that a module consisting entirely of collaborative interdisciplinary science tasks had on students' group work behaviour, attitude and motivation. It was hypothesised that implementing a module based entirely of group tasks would develop positive attitudes and increase student accountability. Previous research indicates that large introductory modules in higher education fail to nurture student motivation to engage with course work. In this study 303 students completed surveys and focus groups that examined the level and nature of group work, student feelings towards group work, and student motivation to complete tasks and attend timetabled class sessions. The findings suggest that in order to complete the science tasks, students typically completed sections individually and consolidated their individual parts to form a complete solution. Collaboration occurred when students completed numerical aspects of the task as students felt these sections demanded group members to share ideas. Collaborative work can promote positive student attitudes, increase students efforts to work on tasks and attend timetabled class sessions. These findings imply that collaborative work may act as a means of promoting attendance and facilitating student engagement in module activities throughout the semester. This study highlights the need for educators to assess learning outcomes achieved in higher education and to distinguish between tasks that promote working collaboratively and collaborative learning.

Introduction

Higher education research highlights the need to develop and measure the learning outcomes students achieve through engaging with higher education courses (Zlatkin-Troitschanskaia et al., 2017; Braun & Mishra 2016). The OECD's *Assessment of higher education learning outcomes* (AHELO) (OECD, 2013) indicated that employers and academic groups have diverging views regarding the most significant outcomes of higher education. Employers recognise communication and teamwork skills as the two most important outcomes whereas academic groups identify discipline knowledge and critical thinking as the most significant outcomes in higher education (OECD, 2013). Typically, instruction in higher education does not facilitate the development of teamwork skills (Riebe et al., 2017; Kirschner et al., 2004), particularly in large introductory modules. A report published by the Irish Department of Education and Skills (Hunt, 2011) stated that higher education institutions need to meet the learning requirements of students. The report states that the onus is on educators to design instruction that nurtures student enthusiasm to learn and engage with learning (Hunt, 2011).

To assist educators in the assessment of twenty-first century skills, Binkley and colleagues (2012, pp.18-19) organised ten skills into four groupings, named *Ways of thinking*

(creativity, critical thinking, metacognition); *Ways of working* (communication, teamwork); *Tools for working* (information literacy, ICT literacy); and *Living in the world* (citizenship, life and career, personal and social responsibility). With this in mind, this preliminary study aimed to investigate an aspect of students' *Ways of working*, by examining student perspectives of a module consisting entirely of interdisciplinary science group tasks. Using surveys and focus groups, we examined the level and nature of group work, student feelings towards group work, student motivation to complete tasks and attend timetabled class sessions. This paper provides new insights into the way group work can influence student attitudes towards completing tasks at undergraduate level. The need to conduct research on approaches to team learning has been identified by researchers internationally (Han & Beyerlein, 2016; Han et al., 2019). No study of this kind has been conducted in Ireland, therefore this paper will inform educators, administrators and policy makers in higher education on a national and international level.

Interdisciplinary group tasks in higher education

The fundamental principle underlying all collaborative learning theories is that it is instruction that involves arranging educational experiences that facilitate students interacting in small groups towards a mutual learning goal (Prince, 2004). Students are interdependent as success for the group obtaining their goal is dependent on each of the group members (O'Donnell, 2006). In cooperative group learning, students may be allocated roles in the group, separate answers are accumulated to build a combined result and procedures by which the group could work more successfully, are debated (Felder & Brent, 2007). Panitz (1999) stated that collaboration is a fundamental principle of student interaction, whereas cooperation is the arrangement of students to their shared goal. Collaborative learning differs from cooperative as it is the building of knowledge between group members, whereas cooperative learning is a practice, which aids students in achieving their shared goal.

The effectiveness of using collaborative work has been reported in various classroom settings (Kirschner et al., 2009). Collaborative learning approaches in higher education have reportedly improved student engagement (Freeman et al., 2014; Prince, 2004; Slavich & Zimbardo, 2012), can decrease student attrition (Springer et al., 1999; Tinto, 2005) and increase student motivation in science, mathematics, engineering and technology courses (Stump et al., 2011; Springer et al., 1999). Other studies have reported that students work harder on tasks and develop positive attitudes towards course work (Johnson et al., 1998; Shibley & Zimmaro, 2002), and suggested that collaborative work fosters a feeling of affinity (Cabrera et al., 2002). Despite the positive reports of the use of collaborative work in education, some students are characterised as being at risk of not benefiting from group work. Evidence has been put forward that students who perceive themselves to be less prepared than their peers have a tendency to disengage from attempting tasks in a group situation, and often report feelings of anxiety when required to work in a group situation (Gijlers & De Jong, 2005).

Stokols, Hall, Taylor and Moser (2008) suggested the orientation of a group tasks can be categorised according to the quality and degree to which integration is achieved, ranging

from unidisciplinary to multidisciplinary, interdisciplinary, and transdisciplinary integration (Table 1).

Table 1: Orientation of group research (Adapted from Stokols et al., 2008)

Orientation	Definition
Unidisciplinary	Participants from one discipline work together to solve a problem.
Multidisciplinary	Participants from two or more different fields work independently to combine their work to solve a problem (Choi & Pak 2006).
Interdisciplinary	Participants from two or more different fields, integrating theoretical ideas and methods from those disciplines to jointly solve a given problem.
Transdisciplinary	Participants from two or more different fields work together to develop shared ideas that "extend discipline-specific knowledge creating new models and language to address a common research problem" (Stokols et al., 2008, p.579).

Developing positive attitudes in higher education

The term affective is derived from the Latin word "affectus" which means feelings. Bandura (1994, p1) described affective practices as "processes that regulate emotional states and elicitation of emotional reactions". It encapsulates a range of paradigms which include beliefs, attitudes and motivation. Fortus (2014) argued that the low percentage of published research (10%) regarding student affect in science education is very concerning. Positive student affect is an important area of science education as research studies report that high achieving students have positive attitudes towards the learning of science (Chan & Bauer, 2015).

For the purpose of this research, student attitude is defined as a positive or negative feeling towards group work. Positive student feelings towards collaborative learning are important as they indicate a student's desire to learn in a group. In a study involving approximately 2050 undergraduate students, Cabrera et al. (2002) found that in all cases collaborative work developed positive student attitudes across gender and minority ethnicity groups. In an educational environment where students attend large lectures and tutorial sessions with mixed program groupings, it is possible that a student's sense of belonging may diminish. It is important in higher education for a student to feel part of a group (Kelly et al., 2019) or community, as student self-perceived involvement has been reportedly related to student learning (Strayhorn, 2012).

Small group work is an environment that cultivates social comparison due to the increased interaction with peers, which could potentially have a negative or positive impact on student affect (Dijkstra et al., 2008). In the 1950s, Festinger produced influential work in relation to human's social comparison concern, which states that humans have a compulsion to evaluate their own attributes, which are based on the attributes of others (Festinger, 1954). Social comparisons can be upward, where students compare themselves to students of apparent higher abilities, or downward where student compare themselves to supposed lower ability students (Micari & Pazos, 2014). In general, students are more

inclined to compare themselves upwardly rather than downwardly (Buunk et al., 2005), resulting in increased student anxiety (Dijkstra et al., 2008).

Developing student motivation in higher education

Science students' motivation to engage in class activities cannot be assumed on the basis that they are studying science at undergraduate level (Voight, 2002). Educators at higher level institutions face the challenge of motivating students to engage in the subject. Brophy (1987) described student motivation as "a student's tendency to find academic activities meaningful and worthwhile and to try to derive the intended academic benefits from them" (pp. 205-206). Researchers have argued that educators should consider student motivation in their teaching as it is an essential element in students' academic success (Voight, 2002; Glynn et al., 2007). Cognitive researchers now identify the high significance motivational aspects have on assisting learning, which is facilitating research into the impact motivational beliefs have on student cognition (Cromley at al., 2016; Pintrich, 2000). The theoretical structure for conceptualising motivational principles can be formed on the foundation that they describe the initiation of student engagement, the level of effort students exert, student persistence on a task, and student achievement on a task (Pintrich, 2003). The leading outcomes derived from motivational theories are termed "indexes of motivation" (Schunk et al., 2008) and are categorised as choice, effort, persistence and achievement. It can be assumed that if a student chooses to perform a task, exerts effort on the task, and perseveres when faced with challenges, they can be deemed as motivated and will have a high achievement on a particular task (Pintrich, 2003).

Extrinsic motivation expresses the motivation to engage in a task to accomplish something else, not an internal desire (Schunk et al., 2008). A student who is interested in undertaking a task or who finds it enjoyable can be thought of as intrinsically motivated to do it. Research findings indicate that intrinsically motivated students are actively engaged in their work, persevere, have positive attitudes towards carrying out a task and high achievement (Pintrich et al., 1993). Intrinsic motivation is negatively correlated to student anxiety (Lepper et al., 2005). The threat of a reduced mark, the pressure to be the best, and acknowledgement from peers are all types of extrinsic motivation that may motivate a student to participate in an activity and exert a large amount of effort. Some researchers may argue that extrinsic motivation detracts from the main aim of increasing students' comprehension of a subject (Voight, 2002); however a high extrinsic motivation does not necessarily mean a low intrinsic motivation.

Purpose of the study

Studies conducted in the area of group work have focused on primary and post primary education; higher education collaborative work is less researched (Loes & Pascarella, 2017; Tsay & Brady, 2010). Furthermore, studies of this nature generally focus on the cognitive domain rather than on the affective domain. The primary goal of this research is to gain insight into the impact a module consisting entirely of group work had on first year

undergraduate science students' attitudes and motivation. The three main research questions being investigated are:

RQ1. When instruction is designed with the intention of promoting group work, how much collaboration actually occurs?
RQ2. What are student attitudes towards carrying out interdisciplinary group tasks in science?
RQ3. Does group work impact students' accountability to attend class sessions or effort on a task?

Method

A convergent parallel design (Creswell & Plano Clark, 2011) was utilised where qualitative and quantitative data gathering took place over the same testing time to confirm, cross-validate, and corroborate findings within a single study. Surveys, focus group discussions and a tutor interview were used to collect data. Surveys were developed by the research team, the intention of the survey was to collect information regarding the ways in which students worked on the task, student attitudes towards the task, and their motivation while collaborating on the tasks. In total, 303 students (Cohort A, n=166; Cohort B, n=137) completed the surveys; both samples were statistically representative at 95% confidence level (5% error). Cohort B completed additional questions that categorised them as having positive or negative feelings towards collaborative work. A representative sample of students was selected from Cohort B, and they were invited to participate in focus group discussions. Seven focus group discussions were facilitated with 26 participants. One group had a high number of students with negative feelings towards group work and therefore a tutor interview was conducted to provide further insights.

Participants and tasks

The participants in this research were first year students enrolled in an "*Interdisciplinary science*" module from a range of Bachelor of Science degree programs. Prior to their registration in the module, all of these students had studied introductory modules in biology, physics and chemistry in their first semester of college. The interdisciplinary science course was a 12 week module that consisted of students working in groups of four to complete a weekly task (McLoughlin, Finlayson & Kelly, 2016). It was intended that the interdisciplinary nature of the tasks would foster student interdependence. A task was introduced and assigned during a one hour lecture, and a two hour timetabled session was used by students to meet and complete their assignment. The module consisted entirely of continuous assessment collaborative tasks. Previous research carried out in the university reported that in general first year students were inclined to engage with course material at the end of the semester, in the lead up to exam time, rather than throughout the semester. The tasks had a range of outputs, which aimed to develop various skills, for example, problem solving (Kelly et al., 2016). One task titled "The oil spill problem" was selected to investigate how students completed an interdisciplinary science task in their group. This problem consisted of an oil spill from a tanker scenario with tasks associated with the environmental 'clean up' by different methods and the longer term analysis of the

environment. Calculations involved possible containment methods on the sea surface, collection methods and storage.

Two cohorts participated in the study, from two successive academic years (Cohort A and Cohort B). Cohort A with 166 students consisted of 48 groups; 30 of these groups were self-selected and 18 were assigned. Similarly, Cohort B with 137 students consisted of 47 groups; 30 of these groups were self-selected and 17 were assigned. Assigned groups were paired at random. Assuming that a course consisting entirely of group work was unfamiliar, at the start of the semester students were instructed to devise "Rules of engagement" for their group. The purpose of this was for students to reflect on the practice of collaborative work, strategise how their group would achieve their goals, anticipate any problems that would hinder them from successfully working together, and encourage positive relationships. Each group's weekly submitted assignment was assessed to give a single mark to the group. Students were also requested to submit a paragraph outlining how they contributed in the group that week. The paragraph was marked on a pass/fail basis, if a student didn't submit the paragraph they did not receive the group mark. The objective of the paragraph was to identify any students who were not engaging with their group's work. Students were not penalised for not attending face to face classes.

Analysis

Quantitative data was coded and entered in *SPSS*. Frequency counts and percentages were calculated to compare responses from Cohort A and Cohort B. Instances where the sample number is lower than the total sample, are a result of students not answering particular questions. Classical content analysis (Onwuegbuzie et al., 2009) was used to analyse both the focus groups and the tutor interview, according to Morgan's (1997) coding framework. Open coding was applied to categorise the data into units. The codes were then clustered into categories. The number of instances of each code was then reported. For the focus groups, a mixed methods content analysis (Onwuegbuzie et al., 2009) approach was utilised.

Results

RQ I: When instruction is designed with the intention of promoting group work, how much collaboration actually occurs?

Students were asked to respond to the statement, "I would prefer to work on my own to solve the problems" to further investigate their preference for individual or collaborative work (Figure 1). A similar trend was identified in both academic years with the majority (A 64%, B 71%) disagreeing that they would prefer to work on their own. This provides evidence that students prefer to engage in collaborative tasks rather than individual tasks.

The extent to which the students collaborated on the task was examined by asking Cohort B students how they researched outside of timetabled sessions, how they divided the task up and how they worked in the timetabled class sessions. The majority (59%) researched independently outside of timetabled sessions, 15% met their group outside of timetabled

sessions and 26% did both. Students stated that they communicated via social media or met face to face and then began to research their part independently. The ease with which students can communicate via technology to discuss tasks is likely to be the reason why so many felt that they could research outside of class, in their own time independently, connecting with their group if needed.

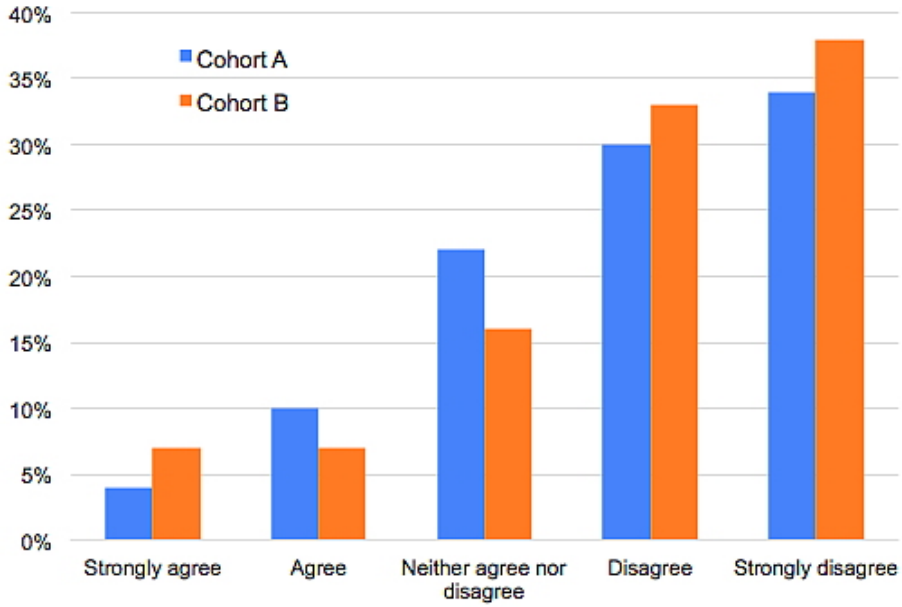

Figure 1: Student response to "I would prefer to work on my own to solve the problems"

To investigate how Cohort B students approached the task, they were asked to state who completed each part of the question (Table 2). Students completed the table in relation to *The oil spill problem*. In general, individual students completed entire parts (range 84% to 93%) of Section A, C, D and E. Section B was approached by students differently however, as only 35% completed the section individually. This suggests that the calculation section promoted more collaborative work than any other section of the task.

Students were asked about how they worked in the two hour timetabled sessions. The majority (57%) worked on sections independently and combined each member's sections to form a complete task solution. Just 26% actually discussed sections before they submitted their task solutions, whilst 16% sometimes worked independently without discussing and other times discussed before completing the task solution.

Focus group discussions (26 students) facilitated further insight into how the students assigned different sections within a group, particularly calculations. The majority (18; 69%) stated that when choosing who did each part, they generally stuck to their "strengths" in that area. One student stated that he avoided calculations for fear of doing them incorrectly:

> I wouldn't be very comfortable with them [calculations] because I know that I wouldn't be able to get a good answer. I just prefer to let someone else do it and do it properly. It's not a negative really if someone else is more comfortable doing something and you can't do it.

Table 2: Student division task (N=134)

Section		Method of division	%
A.	Oil spill clean-up	1 student completed whole section	84
		Section divided between more than 1 student	7
		More than 1 student worked on a single part of a section	9
B.	Calculation	1 student completed whole section	35
		Section divided between more than 1 student	44
		More than 1 student worked on a single part of a section	21
C.	Barley properties	1 student completed whole section	93
		Section divided between more than 1 student	3
		More than 1 student worked on a single part of a section	4
D.	Titration	1 student completed whole section	87
		Section divided between more than 1 student	8
		More than 1 student worked on a single part of a section	5
E.	Light scattering technique	1 student completed whole section	87
		Section divided between more than 1 student	0
		More than 1 student worked on a single part of a section	13

Another student claimed that the calculations were randomly split up into sections and a part was allocated to each group member. One student stated that she needed assistance from a group member when she was doing the calculation section of a problem and therefore needed to collaborate to complete it. Furthermore, 18 (69%) stated that each student selected the part they preferred to do the most "Everyone just picked what they wanted… whoever saw a part that they liked, they said yeah I'll do that part". Taking into account this information, it could be inferred that the calculation section was not the preferred section for students to complete on their own.

RQ 2: What are students' attitudes towards carrying out interdisciplinary group tasks in science?

Students in Cohort B were asked to state their feelings in relation to conducting tasks collaboratively. The question was open ended and student responses were coded and characterised as negative, positive, both negative and positive, or indifferent. In total, 63% of 120 respondents (17 students did not complete the question) stated a positive feeling, 25% a negative feeling, 5% expressed both positive and negative feelings and 7% of students felt no different to working individually.

Range of positive feelings

The data collected in this research indicated that 75 (63%) of 120 Cohort B respondents had positive feelings towards working collaboratively (Table 3). Students used a variety of positive terms to express how working in a group made them feel, they included, good,

happy, comfortable, supported, motivated, useful, productive, confident, relieved, important, fun, excited, appreciated and interested.

Table 3: Positive student feelings towards collaborative work (open response)

% (n=75)	Code	Typical response
36%	Variations of word "good"	Typically students stated that they felt good working in a group because of the positive interaction with peers.
17%	Happy	"Working in a group made me feel happy because I have fun working with people"
15%	Useful/important	Felt important as "everyone has an input", were "part of a team" and group members "listened and took opinion seriously".
12%	Supported	Group members "will help with any problems you may have", One student explained that he felt relieved to be sharing the workload of the project.
11%	Comfortable	"Everyone did their own share of work, no extra load on other people". Another student explained "it can be daunting alone".

Range of negative feelings

In total, 30 (25%) of 120 Cohort B respondents stated negative feelings towards collaborative work. The main negative feelings stated were anxious, frustrated, under pressure, confined, stressed, tired, uncomfortable, unhappy and distracted (Table 4).

Table 4: Categorisation of negative student feelings (open response)

% (n=30)	Code	Typical response
23%	Anxious	Students were anxious due to the standard of work either "depending on others work to be of the same standard" or to "perform well" in a group. Poor communication skills were also noted by one student as a reason for being anxious
18%	Frustrated	Student Y commented "Working/being dependence on other people's competence for a grade is annoying". Student P in the same group was also frustrated but not by the other group members as he "Felt like I wasn't contributing enough even though was trying to."
13%	Under pressure	"I had to make sure that all the work I was assigned was done correctly otherwise the group would suffer."
13%	Restricted	Students explained that they felt confined as they were dependent on other students, had to work at specific times or even doing the work at all was restrictive.
10%	Tired	Students explained that trying to make their work and the group members work "blend" together was tiresome.
10%	Uncomfortable	Being dominated by other group members and not knowing what their role was in the group.

Other

Just 5 (4%) of 120 Cohort B respondents stated mixed feelings regarding collaborative work. One student commented that she "Found it difficult to divide the workload but

enjoyed seeing other perspectives." Another student commented that he was "Glad for being able to rely on others, stressed about keeping my work at a similar standard to theirs." These student explanations depict justifiable accounts for having mixed feeling towards collaborative work. Overall, 7% of students were indifferent to the use of collaborative work and expressed that they didn't feel any different working collaboratively than they did working independently. One student explained that as he was confident his group members would do their share of the work, he didn't have strong feelings regarding collaboration.

Room location and individual student feelings

For Cohort B, all 47 groups were divided across four classrooms for the two hour timetabled session each week. The three main variables that existed between student groups in the four rooms were class size, tutor, and how the groups were formed. Rooms 1-3 held 10 groups each, students in these rooms self-selected their groups and each room had two tutors. Room 4 held 17 groups, groups were assigned and 4 tutors were allocated to the room. It was hypothesised that students in Room 4 would have a higher percentage of students with negative feelings towards working collaboratively, this however was not found. The room with the highest percentage of negative feelings and the lower percentage of positive feelings was Room 2 (Figure 2). This group had the same class size and method of assigning groups as Rooms 1 and Room 3. This provides evidence that class size and whether the students self-selected their groups did not have an impact on their feelings about working in a group.

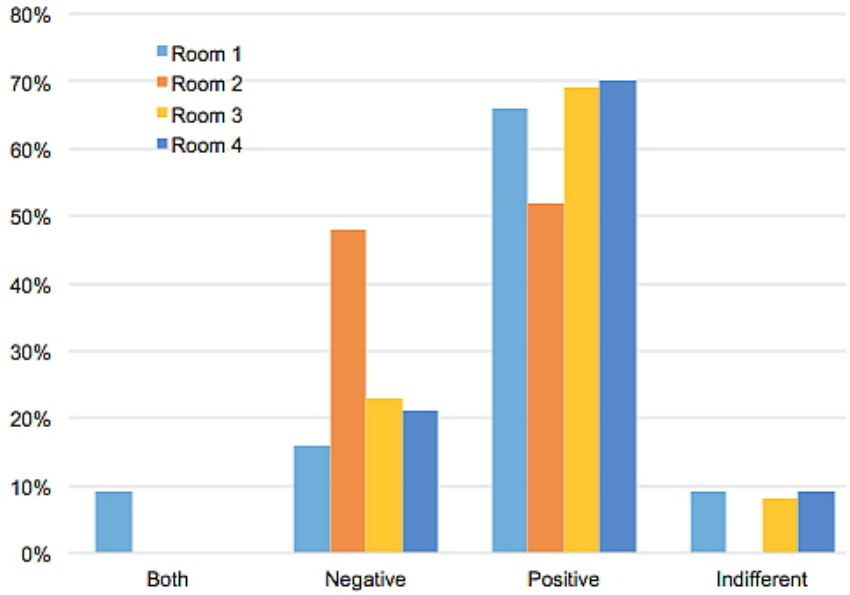

Figure 2: Students' feelings towards collaboration by room location

To further investigate students' negative feelings towards collaborative work in Room 2, the tutor in that room was interviewed. Two tutors were assigned in this room, making

them accountable for five groups each. The tutors believed that repeated poor attendance by group members and low levels of tutor feedback to the groups were responsible for negative student feelings in Room 2. One tutor stated that Group M consisted of three male students, two with regular attendance and one poor attendance. She believed the reason two of these students reported being anxious was due to the lack of effort by their absent group member, which agrees with open ended statements put forward by these students in their survey responses.

Group R only had two group members who attended consistently. These two students believed they had to carry out double the work to complete the assignment. The tutor proposed that this caused frustration, which was confirmed in these student survey responses. The tutor stated she corrected and gave feedback to the same five groups throughout the semester. The other five groups had one tutor for the first half of the semester and a different tutor for the remaining part of the semester. The tutor for the second half was unable to attend the class session for three weeks and therefore the students did not receive corrections or feedback for several weeks. The tutor believed that this was a contributing factor to negative student views about working collaboratively.

RQ 3: Does group work impact effort on a task or accountability to attend timetabled sessions?

To investigate how students viewed their contribution they were asked to respond to the statement, "I make a large input into the work of my group". The parallels between both cohorts are displayed in Figure 3, with the majority (A 92%, B 88%) stating that they made a strong contribution to their group.

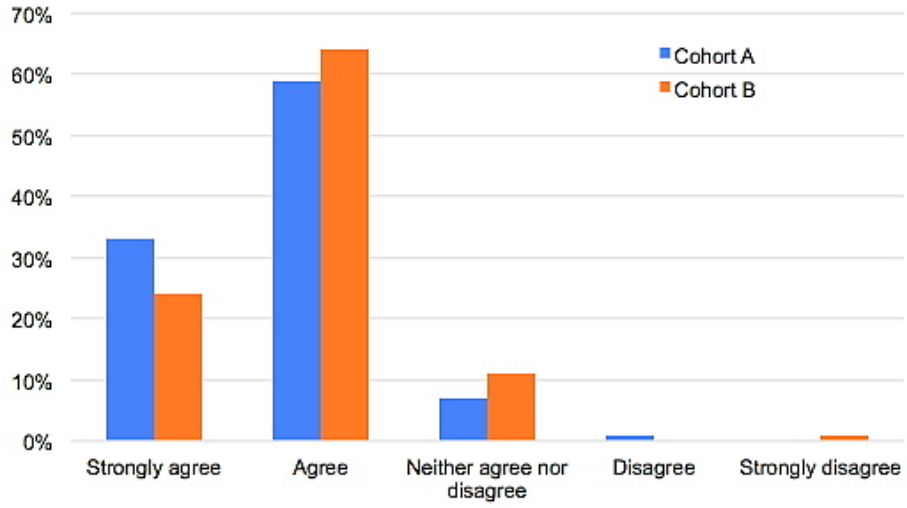

Figure 3: Student response to "I make a large input into the work of my group"

To investigate if students believed that their group exerted effort to complete their tasks they were asked to respond to the statement in Figure 4. A similar trend emerged with the

majority (A 79%, B 78%) of both cohorts agreeing strongly that their groups employed effort.

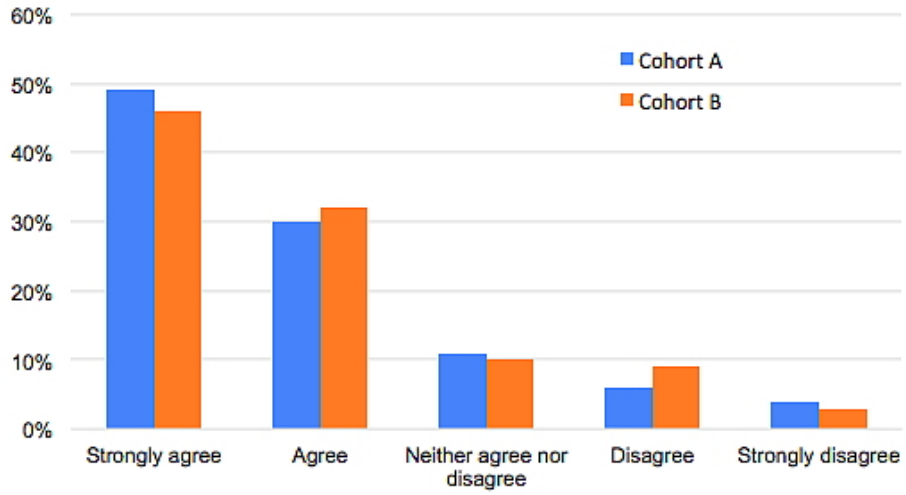

Figure 4: Student response to "My group functions well, everyone makes an effort"

Evidence of student motivation was investigated in two areas, student opinions regarding their attendance at timetabled sessions, and the effort they exerted on the tasks. It was hypothesised that students would feel more responsibility to attend timetabled sessions due to the group work aspect of the course. It was also hypothesised that the students would feel more of an obligation to exert effort on course tasks, due to the social pressure of working in a group.

Focus group discussions facilitated further insight. 23 students discussed whether they felt a greater responsibility to attend timetabled class sessions. Overall, 17 (74%) stated that they felt a greater responsibility to attend timetabled sessions. Students explained that this responsibility was motivated by the need to not disappoint their group members. One student explained:

> I'd feel worse, letting them down if I wasn't there rather than just deciding my grade, I would feel bad if I wasn't there for them. It effects other people as well, it's not just yourself that your letting down by not going.

Other students explained that their motivation to attend was grade driven. One student stated:

> Yes, I don't want to leave my grade up to other people. They are affecting my grade and I am affecting their grade .... I have missed a lot of lectures but my attendance is better for this module.

In total, 5 students (22%) said that their attendance was not better for lectures but it was for the group timetabled sessions. They all stated that this was because the task was

available on an online learning platform; therefore they saw no benefit in attending the lecture.

In focus group discussions, 18 students offered their viewpoints regarding the amount of effort they exerted on the collaborative tasks. 15 students (83%) agreed that they worked harder in the module, and the reasons given were that they were socially driven as they did not want to disappoint group members, they were group grade motivated, and they needed to work harder to compensate for a group members potentially inadequate performance. The remaining 3 students (17%) stated that they put the same amount of effort into working on collaborative tasks as they would if they were working individually. No student claimed that they felt they could exert less effort due to the collaborative nature of the tasks.

Summary of main findings

- The majority of students researched independently outside of timetabled class time before they met their group and completed an entire section by themselves. Students divided the task according to their strengths/subject knowledge and the emphasis was on getting the problem completed most efficiently rather than on shared learning.
- The calculation section promoted more collaborative work than any other section of the task.
- Almost two thirds of students had positive feelings towards working in a group and one quarter of students had negative feelings towards working on the group task. Absent group members and poor tutor feedback were two factors that caused negative feelings.
- Overall, students believed they made a strong contribution to their group and believed their group members made a valuable input. Feeling a greater responsibility to group members and grade motivation were cited as the two main reasons for increased efforts.

Discussion

In planning this research, we envisaged that the tasks in this module were facilitating collaborative learning; however this was not the case. The evidence put forward by this research suggests that in general students allocated individual roles to group members so that they worked in parallel to complete a section and combined their individual parts at the end. Some may argue that in essence students were working independently rather than collaboratively. However, students were assessed as a whole; therefore the success of each student's grade depended on the whole product so it cannot be denied that students were interdependent (O'Donnell, 2006). In most cases it did not appear that students were using the opportunities to interact to advance their learning, more so to achieve their shared goal of completing the task. While the tasks were designed with the intention of being interdisciplinary, in general groups used a multidisciplinary approach. This finding highlights the need for educators to assess learning outcomes and to distinguish between tasks that promote working collaboratively and collaborative learning as they are not

interchangeable terms. A limitation of this study is that our findings may underestimate the full nature of collaboration relating to the steps taken to complete sections of the task. Our methodology included a formalised group task, conducted in the form of continuous assessment, problem-solving in nature and leading to the completion of an assignment. Information concerning the informal settings of group tasks, such as the level of communications outside of assigned class time were not included in the main analysis.

Evidence put forward in this research suggests that the nature of a problem impacts how students work. Collaborative learning increased in instances where students required support, therefore necessitating group members to share knowledge, strategies and interpretations. Students were strategic in their approach to working on tasks. Where possible, they subdivided the task based on the emphasis of the discipline associated with it and each student completed the subject they associated with. More students collaborated on the calculation section, whether they felt it was too difficult to complete on their own, or they disliked the calculation section. This finding supports the overall findings of other studies that conclude challenging numerical problems increase collaborative learning (Kelly et al., 2016; Xun & Land, 2004). This finding could be applicable to more informal settings of group tasks, such as educators facilitating the use of forums on discussion boards to encourage student collaboration on challenging numerical problems, or to encourage monitoring and reflection of problem solutions (Kelly et al, 2016).

In this study, collaborative work promoted positive student attitudes. This may be because of the allocated class time to collaborate on tasks and tutor guidance during this time. LaBeouf et al. (2016) reported that students disliked group tasks, due to difficulty in scheduling meetings and agreed timelines for task completion. It was documented that the balance of positive and negative feelings were similar in classes, despite variations in class size and whether the students self-selected members; this contradicts existing literature (Wilkinson & Fung, 2002). Student absenteeism from a group and tutor feedback were variables that caused a high incidence of negative student feelings. Lai (2011) agreed that poor student feedback is detrimental to successful collaborative work. The changing landscape of higher education suggests that we are moving inevitably towards virtual learning spaces. The use of technology as a tool to provide tutor feedback to groups, or to include an assessment structure for non-attendees in face to face classes could address these shortcomings.

From the students' perspective, they felt more inclined to attend collaborative class sessions and to work harder in timetabled sessions. Students felt motivated to attend timetabled sessions due to the collaborative nature of the course, as they did not want to disappoint their group members. Students also claimed to work harder on group tasks; this was driven by social pressure from the group, grade pressure from group grading, and compensating for inadequacies in other group members efforts. This finding provides evidence that group work can be a powerful extrinsic motivator of first year undergraduate students. This is a positive finding as many researchers have reported on the relationship between motivation and student achievement (Glynn et al., 2007). Increased student accountability regarding student attendance rates and student effort are

very important, due to the high attrition rates of first year students reported by higher education institutions at a national (Mooney et al., 2010) and international level (Chen & Soldner, 2013).

Higher education institutions aim to contribute to cultural and social significance by inspiring students to become self-regulated learners in their chosen fields. An education environment that aims to inspire engagement in learning needs to motivate students to engage (McCarthy 2016). This research has put forward evidence that the use of weekly collaborative tasks in an undergraduate course increased students' motivation to attend timetabled class sessions and work harder on tasks. It is proposed that introducing interdisciplinary collaborative instructional design structures in first year undergraduate modules is a positive move towards organising assessments and supporting learning.

Conclusion and implications

The results of our investigation brought us to some important conclusions. Using interdisciplinary science tasks does not necessarily lead to collaborative learning. To nurture collaborative learning, tasks need to be at a challenging level where the students feel collaborative work is required to complete it, for example, calculation sections. Collaborative tasks increase student accountability to attend timetabled sessions and exert effort on tasks, two factors that improve student prospects in persisting (Loes & Pascarella, 2017). The findings from our study have important implications for educators and higher education policy makers.

- Educators: Group work can be used as a tool to increase independent learning outside of timetabled sessions, improve class attendance in first year undergraduate modules and student efforts on tasks throughout the module. Regarding factors that may hinder positive feelings towards collaboration, two key areas should be considered. Firstly, the importance of tutor feedback to groups in the week following their assignment submission - specific sections may be marked as substandard to provide an incentive to the students to monitor their group member's work. Secondly, tutors should note regular student absenteeism from groups, offering advice to remaining group members about how they may rectify their situation.

- Higher education policy makers: There is a need to support teaching strategies in higher education that promote student accountability and effort on module tasks. There is high expenditure by institutions on student learning support services, when more investment should be spent enhancing effective teaching behaviours among faculty, and supporting innovative teaching strategies in large modules.

In Ireland and across the globe, the Coronavirus 2019 (COVID-19) pandemic demands that higher education institutions urgently create online modules and course content (Crawford et al, 2020). This provides educators with the opportunity to use experiences from face to face teaching in virtual learning spaces. Going forward, it is important we

create ways to facilitate collaborative group work and promote student motivation and accountability in an online environment.

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