An analysis of team projects outcomes from student and instructor perspectives in online computing degrees

European Journal of Open, Distance and E-Learning • 25(1) • 2023 • 1-12
DOI: 10.2478/eurodl-2023-0001

sciendo

European Journal of Open, Distance and E-Learning

An analysis of team projects outcomes from student and instructor perspectives in online computing degrees

Research Article

Nkaepe Olaniyi[1*], Douglas Millward[2], Cathryn Peoples[3]

[1]MKC Training Services. Professional Engineering Wing, Royal School of Military Engineering, Chatham, Kent ME4 4UG, Email: nkaepe.olaniyi@midkent.ac.uk
[2]University of Essex, Wivenhoe Park, Colchester CO4 3SQ, Email: douglas.millward@online.essex.ac.uk
[3]Ulster University, Belfast, United Kingdom, BT15 1AP, Email: c.peoples@ulster.ac.uk

Abstract: One of the core aims of higher education degrees is to provide an environment for students to acquire essential skills that will help them in the workplace. Team working is one of those essential skill and it is also one that experience and research show is regularly resisted by students. This resistance can become even more amplified when the degree is delivered online, although some have pointed out that a good team provides much-needed community spirit and support in such environments. The purpose of this study is to review the delivery of a team assessment format that has been specifically designed for the online environment. The results presented provide insight into the student's perspective on the delivery as well as the reflections of the instructors involved in the delivery. The overall outcome is positive for both parties and provides further guidance on implementation to ensure the pedagogical design continues to be viable. This includes insights into team composition, instructor involvement, and peer review scoring formats.

Keywords: *International distance learning; Team/group work; Postgraduate; Social constructivism; Peer scoring; Synchronous teaching and learning*

Introduction

Team working is an essential skill required in any university graduate and is particularly important in programmes aiming to impart computing knowledge (Shneiderman, 2016; Vivian et al., 2013). The stereotype of the solitary coder, wearing a hoodie and hunched over a machine with three (sometimes up to five) screens is becoming a thing of the past (Cheryan et al., 2015; Vera, 2021). Employers are keen to ensure that their computing employees can function in a team (Hiter, 2021; Riebe et al., 2010; Vogler et al., 2018), and some even use this as an interview differentiator. Group work is highlighted as an assessment example by the Quality Assurance Agency (QAA) benchmark statement for master's programmes in computing (Quality Assurance Agency for Higher Education, 2019). In fact, peer assessment is seen as offering an opportunity for "innovative and flexible means of assessment" (Quality Assurance Agency for Higher Education, 2019). In line with industry expectations, Professional Accreditation, Professional Statutory and Regulatory Bodies (PSRBs) such as The Chartered Institute for IT (BCS) in the UK, also require the inclusion of team-working skills in the development and delivery of applicable Computing Programmes (The Chartered Institute for IT [BCS], 2020). Furthermore, the social constructivist approach to learning is based on the concept that knowledge develops because of learners' interactions with others, and that learning is therefore a shared experience, not an individual one; this extends ideas around the importance of synchronous learning in distance education (Peterson et al., 2018). Considering these requirements, many higher education (HE) institutions ensure team projects are included in their curriculum design. Both the research literature and experiences of the research team reinforce the fact that team work is challenging for students and can be resisted (Tucker & Abbasi, 2016). These effects are particularly amplified in the online learning environment (Smith et al., 2011), as utilised by the University of Essex Online (UoEO), the institution which is the focus of this case study. With an increasing move to blended or fully online delivery, considering the forced migration during the coronavirus (COVID-19) pandemic, there is a need to ensure the utilisation of an effective means of the delivery and assessment of team projects. A selection of steps taken to facilitate effective team work practices is discussed

* E-mail: nkaepe.olaniyi@midkent.ac.uk

in the literature, for both the face-to-face (Gardner & Korth, 1998; Hosam & Noria, 2018) and online learning environments (Falls et al., 2014). Research published as recently as 2021 indicates that this is an ongoing research challenge (Wildman et al., 2021) and one that commands further research today. Hence, this research aims to provide an in-depth understanding of a viable team project delivery process in an online environment for computing students.

In line with the benefits of team working as highlighted above, and the widespread industry demand for this skill, all postgraduate computing programmes offered by the University include team projects, which contribute 60%–70% of the overall mark for an applicable module. This responds to the programme learning outcome, 'Working with others', which is included in the Key Skills outcome of each programme: "Develop and apply key team-working skills by working with peers to develop and implement plans, as well as explore and develop viable computing solutions, as applied in, for example, software development." Similar learning outcomes are specified for all applicable modules across the computing programmes; assessments that provide students with the opportunity to demonstrate the ways in which they meet this learning outcome are provided.

At this point, it is best to address the elephant in the room: are we focussing on team or group assessments? This needs clarification as there is a significant difference in how each of these operates. In a group project, there is usually very little interaction between members. Each member does a specific task without learning much from the other members of the team. On the other hand, in a team project, consensus must be reached as the members work collaboratively to achieve a common goal (Pursel, n.d). This is sometimes referred to as students working "as a group" (collaboratively) compared to working "in a group" (cooperatively) (Chiriac, 2014). The operational ramifications of this distinction constitute the most common reason why employers rate team-working skills so highly. . The question then arises as to how such skills can be developed in an academic setting.

Getting students to work as a group/team has been a regular feature in many HE programmes, cutting across disciplines. This is due to the noticeable increase in student achievement, collaboration, motivation, and self-efficacy (Chiriac, 2014; Wilson et al., 2018; Chang & Brickman, 2018). However, such tasks have not been implemented without equally noticeable challenges, which include negative student experience (non-participating members/free-riders, overbearing members, interpersonal conflicts) and implementation issues (composition, structures, and norms, assessing individual contributions) (Wilson et al., 2018; Thorn, 2020). These implementation issues can be exacerbated when dealing with virtual teams, as we have in the Computing Master's programmes delivered by the UoEO (Morrison-Smith & Ruiz, 2020). The pragmatic issues observed concerning the virtual teamwork activities forming part of the online curricula of several university programmes have given rise the requirement for improving the online delivery of learning, since the elimination of online assessments from the curriculum is not an option for many institutions, as explained in the Introduction. (Thorn, 2020).

With the move to fully online/blended educational delivery, we recognise that a research gap continues to persist around team work processes that work, and that many in academia are keen to hear about how such processes can be utilised in their discipline. Though this study cannot guarantee outcomes in other disciplines, it does provide a starting point for review. Hence, to achieve the aim of providing an in-depth understanding of a viable team project delivery process in an online environment for computing students, answers to the following questions, based on student and instructor experiences (Chiriac, 2014), are required:

- In what ways does team work contribute to (your) learning?
- In what ways does team work create an online learning community in your module(s)?
- What positive experiences have you had while working in/supporting team(s) in your module(s)?
- What negative experiences have you had while working in/supporting team(s) in your module(s)?

The interview/focus group questions utilised were based on research undertaken by Chang and Brickman (2018) and focuses on the core questions above (see Appendix A). The study by Chang and Brickman (2018) does encompass some of the processes used in fostering collaborations in teams. Their results enhance the outcomes of this case study, as well as bringing to the fore issues that still need addressing, which we do attempt to address in this paper.

Context

The computing programmes delivered by the UoEO in the timeframe considered in this paper (2020–2021) are conversion master's in computer science and cyber security. These programmes are aimed at noncomputing graduates, providing them with an entry route into the computing industry. It should be noted that we typically have more students in the Cyber Security Programme than in the Computer Science programme.

Delivery of the team assessments in these programmes is based on extended research and brings together best practices from various institutions (Chapman Learning Commons, 2016; Race, 2001; University of Waterloo, n.d. - a). The process involved in the delivery of the team work opportunity and good team-working practices in general is as follows:

- An Introductory session in Week 1 of the module where the instructor allocates teams based on time zones and experience (based on the information available on their learning platform profile), while still maintaining diversity among team members (Freeman et al., 2017). The teams are then asked to draw up a team contract, assigning roles and tasks to each team member to ensure they can achieve the given goal(s) for the project/assignment in the given timescale. The signed contract is then shared with the module instructor. While it is not formally graded, it is used as an artefact that students are required to reflect on later in the module (see below).
- Teams can update the module instructor on their progress during the biweekly synchronous sessions. Where this is not possible, the team will be encouraged to choose a time that suits all parties. There should be regular team meetings that will need to be recorded and logged in each student's module e-portfolio (Olaniyi, 2020). This will be open to instructor review if the e-portfolio is a piece of summative assessment for the module. This interaction also provides the instructor with further insights on the team's synergies, which is valuable when it comes to moderating individual team member scores.
- To determine the final score of each team member for the project/assignment, peer assessment is used. Apart from providing an individual grade for each team member, using peer assessment has the advantage of enhancing understanding and improving the learning experience in the team (Huisman et al., 2017; Teaching and Learning Services, 2018; Teaching and Learning Services, 2021). Students rate the contribution of their team members (on a scale of +5 to –5, where 0 means an equal amount of effort was applied by each team member) based on five criteria (attendance, contribution, preparation, attitude to work, and task completion) (University of Waterloo, n.d. - b) (see Appendix B). Details on the process for peer assessment is made available to students at the outset of the applicable module. Students are also told that if they fail to submit a peer assessment form, the instructor will determine their individual score.
- The final aspect is an individual reflection as a single piece of assessment or part of their e-portfolio submission. This allows the student to reflect further on being part of a (development) team, as well as their individual contributions to the project.

This process has been utilised in four modules since January 2021, with generally positive feedback from both students and staff. The External Examiner for the MSc Cyber Security degree programme highlighted (2020–21 academic year report) this assessment format as an example of good practice and innovation. The four modules are the focus of the study and are titled as follows: Information Risk Management, Secure Software Development (Computer Science), Secure Software Development (Cyber Security), and Network and Information Systems Management.

Methodology

A case study approach was used, relying on qualitative data to provide insightful information on the team project delivery mechanism. The qualitative data from the students were mapped against the quantitative assessment grades. The protocol used for this study is detailed as follows (Pervan & Maimbo, 2005; Yin, 2017):

Phase 1 – Case study design (defining the research questions and selecting the population for the study/ setting boundaries for the study). The real-world case for our abstraction is the small group of students in the UoEO Computing programmes who take on a module with team-based assessments. The context of delivery is described above.

Phase 2 – Data collection and analysis. The rest of this section provides an overview of the data collection process while the Presentation of Findings section details the analysis. The research questions formed the basis for the interview questions used and this is described in Appendix A.

Phase 3 – Comparison with literature and reporting. Outcomes of the study are compared to available research literature.

Students across the four aforementioned modules were invited to participate in the research project via online focus groups and/or individual interviews. The two instructors of these modules are part of the research team and provide their perspectives on the delivery in this paper. The modules include those taught in

the MSc Computer Science and MSc Cyber Security Conversion programmes. Ethical approval was sought from and granted by the University before students were contacted. Information on the four modules used for the study is as follows (Table 1):
IRM, information risk management; NISM, network and information security management; SSD, secure software development; SSDCS, Secure Software Development (Computer Science).

In total, six students agreed to take part in the study, where one was only available for one-to-one interviews while the others took part in focus group discussions. The same set of questions was asked of all participants regardless of mode of participation. The output of these interviews (the next section) was collated according to discipline, to determine if this would affect the responses to the research questions posed. The viewpoints of the instructors are also captured in the next section, to provide further insight to the responses.

Presentation of Findings

Core aspects of the student team work experiences will be discussed in the following section, correlated with the overall module performance of the students. It also

Table 1. Information on modules used in the study

Programme	Module details	No. of students/Structure of the teams	Module assessment structure
Cyber Security	IRM January to March 2021. (Instructor – DM*) Module introduces the concepts of information risk management.	10 students – two teams of three students and two teams of two students	A 6-week module with three assessment points. The first two assessments produce outputs from a team project (Weeks 3 and 6) and have a combined worth of 70% of the final module score. The third assessment is a reflection component, based on evaluating a key event during the module and submitted in Week 6 (worth 30% of the final module score).
Cyber Security	SSD March to April 2021 (Instructor – DM) Module deals with the design of code in a secure manner, accommodating aspects such as encryption of data at rest and confidentiality of data in transit	Same group of students from the preceding module (IRM) – 10 students, three teams comprising four, four, and two students, respectively. Team A was the same as in IRM and was one of the excellent groups. Team B had some excellent characteristics but was more mixed due to limited numbers. (It is worth noting that the creation of the team of two was down to the resistance of one student to participating in a team project.)	A 6-week module with three assessment points. The first two assessments produce outputs from a team project (Weeks 3 and 6) and have a combined worth of 70% of the final module score. The third assessment is a reflection component, based on evaluating a key event during the module and submitted in Week 6 (worth 30% of the final module score).
Computer Science (first instance)	SSDCS May to July 2021 (Instructor – CP*)	13 students, three teams of three students and one team of four students	A 12-week module with three assessment points. The first two assessments produce outputs from a team project (Weeks 6 and 11) and have a combined worth of 60% of the final module score. The third assessment is an e-portfolio submission, capturing individual contributions to the project and reflections, submitted in Week 12 (worth 40% of the final module score).
Computer Science (second instance)	SSDCS August to October 2021 (Instructor – CP)	12 students, four teams of three students	As described above
Computer Science and Cyber Security	NISM May to July 2021 (Instructor – DM) Module accommodates network security and introduces students to the basics of network penetration tools	NISM was the first module we ran concurrently for both Computer Science (14 students) and Cyber Security (22 students) programmes. There were eight teams in total – all had at least four members, and some had more due to the distribution of students across the cohorts.	A 12-week module with three assessment points. The first two assessments produce outputs from a team project (Weeks 6 and 11) and have a combined worth of 60% of the final module score. The third assessment is an e-portfolio submission, capturing individual contributions to the project and reflections, submitted in Week 12 (worth 40% of the final module score).

*refers to authors' initials.

includes instructor reflections on the implementation of this assessment design. Based on a qualitative evaluation of the performance of groups, we state our observations on the strengths of the team work experience.

Computer science team work experiences

Firstly, the results can be discussed from the perspective of the teams from the May-to-July-2021 run of the SSD module, as well as the instructor's perspectives on the delivery and outcomes. The profiles of the students from this module who took part in the focus group are presented in Table 2. The outcomes of the interviews are reviewed in this section based on the research questions posed in the Introduction.

- **In what ways does team work contribute to (your) learning?**

There is evidence that the team-working experience becomes a fundamental part of the student learning process, with Student B joking that he talked more with his team than he did with his wife. During the focus group, he admitted that '*We met almost every night without any issues*.' Student B repeated throughout the module and the focus group that he believed that belonging to a 'good group' is a matter of luck. Trying to support this student's learning in relation to the team-working experience, he was given feedback to try to help him to explore this thought process more deeply, in the sense of how he might react if assigned into a team that was naturally less effective, to get the most out of the team. There was limited evidence provided, however, that these questions were examined by the student.

- **In what ways does team work create an online learning community in your module(s)?**

Working in teams and building familiarity between students may additionally bring some disadvantages. In one particular example, two students decided that they would not participate in group seminars. They believed that they were the only ones who responded to questions and discussions and felt that they were contributing more than other students. Effort was made to communicate with these students that their actions would ultimately cause their own learning to suffer, but this did not have any consequence on their behaviours. There was an impression that this was a matter they had discussed while working as part of their team. Nonetheless, as a result of their decisions, there were no negative consequences on the seminar itself, with the other students possibly even having more freedom to join the discussions without these members present.

- **What negative experiences have you had while working in/supporting team(s) in your module(s)?**

While the students in this cohort were assigned into groups based on location, it can be appreciated that there remained to be a significant difference in time between all team members, such as the time delay between USA and the UK, and between the UK and Israel. This became more apparently problematic in the case of Team 3 for Student A, when the team member located in the USA attended team meetings less frequently than the others. Student A acknowledged during the focus group conversation that, as a result of a single team member missing meetings, he then had to spend time in one-to-one meetings to ensure that the absent student was up to date with current team progress. While Student A was not the team leader, this student still took responsibility for ensuring that all members of the group had a consistent view of the progress made to date.

In each of these teams, there was a team member who did not participate as significantly as the others. This fact was identifiable by the instructor through the evidence from the mark for their e-portfolio – this mark indicated that they were unlikely to have scored as highly overall for the design document and code developments if they were not working as part of a team. While there were some gentle indications of this given from the teams, such as noting that a particular team member did not join meetings as frequently, for example, there were no stronger communications of this fact from teams to

Table 2. Profile of Computer Science participants

Student participant and gender	Age bracket (years)	Team size	Team distribution	Design document mark (%)	Software development mark (%)	e-Portfolio mark (%)
Student A (Male)	25–34	Three	UK, USA, and UK	60	97	78
Student B (Male)	55–64	Four	South Africa, Israel, and UK	95	100	90

the instructor. The teams in this respect appeared to be resolved to the situation within which they were working.

- **What positive experiences have you had while working in/supporting team(s) in your module(s)?**

In line with the idea that the team work experience fuels learning according to a social constructivist approach (Fini et al., 2018), it is perhaps not surprising that the students in the focus groups described the benefits that they had received as a consequence of their instructors being involved in their team work. The major benefits were reported as being received when the instructor participated in ways that went beyond what they might be 'expected' to do, such as becoming involved in irregular and ad hoc participation with students. If students are expected to learn from the team work experience and from the people they are interacting with, then it may be assumed that they will learn to greater degrees when there is a wider variety of participants in the team. While the instructors involved were happy to do this, it cannot be assumed that all instructors would be.

It may be relevant to note that the students who participated in the focus groups are strong and competent students. However, this is not to say that they are the most competent software developers. A few of them also agreed that, at the beginning of the module, they were hesitant about the team work experience. By the end of the process, however, all were satisfied with the experience that they had gone through. These are the types of students who are more likely to get the most out of any learning opportunity than weaker students. This may be a factor in the positive groupwork experiences reported.

The evidence suggests that the contract plays a relatively superficial role in managing the team-working process. As participant Student B admitted, '*If the people are less disciplined then a contract is important. But we didn't take it seriously*.' Student B was one member of a particularly competent team. Once the contract was prepared, there were little further obvious signs that they were referred to or used by students in the module. The experience is that they are typically written and sent to the instructor by the end of Week 1, with no further reference being made to them beyond this. This became clear when marking the e-portfolios, with students not necessarily including copies of the team contract, and reflections on the contract itself were even less prevalent.

From an academic perspective, the overall role played by the team project may be questionable, particularly from the perspective of an MSc degree. At this level, it might be expected that students are studying because they want to learn, and not necessarily from the perspective of 'getting a degree'. Taking this idea further, it was interesting that one student acknowledged during the focus group that this would be the type of scenario that would be encountered in real life, and on that basis, he accepted it. In saying this, he was referring to the fact that it is common to have to work in a team, where perhaps not everyone contributes in an equal way. This viewpoint was somewhat surprising to the instructor, given that the student is paying for their own educational experience which, as a consequence of working in a team, will be impacted on by the behaviours of others. This finding may demonstrate, however, the maturity of the students and recognition of the full suite of benefits they will get out of the experience.

Further instructor reflections – computer science

Considering in more depth beyond the focus groups the organisation of students into teams, for one cohort, the instructor assigned students into teams and one student contacted the instructor to ask if they could instead be in a team with at least one of two other named students. This was due to his familiarity with the students through past experience, and his knowledge of their approaches and compatibilities. He was subsequently allocated into a group of his choice, and overall, the team performed highly. Taking this experience into account, in a later cohort, the instructor offered students the opportunity to self-organise into groups. Interestingly, the students did not wish to make use of this opportunity and preferred to be allocated into teams by the instructor. Further of interest in relation to team organisation, it has been observed that teams that were allocated in SSD have self-organised into the same groups in a later module – the formation of bonds during one module could then be exploited further. However, the unpredictable nature of a design to self-organise or not makes it more difficult to offer a single approach that can be guaranteed to respond to the needs of all students, and it may be the case that a degree of openness is required by the instructor in the allocation and potential reallocation of teams at the beginning of a module.

Despite the discussion around the contract possibly playing a superficial role during the focus group, there was a scenario where the contract did have a role to play, in the resolution of a dispute between two students. One student was dissatisfied with the contribution being made by another team member, and instead of speaking directly to the team member, as had been agreed in the team contract, she first spoke to the instructor. When

the instructor then spoke to the other student, he was confused about the reasons why the student had spoken to the instructor, as that line of action had not been agreed in their team contract. In this instance, the contract therefore could have played a valuable role, if all students had followed the decisions initially agreed upon.

While the team organisation approach is primarily based on location, and there were some challenges associated with this discussed during the focus group, in one situation, the instructor paired students firstly according to gender, and then according to time zone. The notion of gender was used as an influential factor, in recognition of the fact that females can become marginalised in engineering groups (Russo & Stol, 2020). In this cohort, there were three females, who were assigned to a team with one another. There were no complaints from the team about this and they appeared to have a beneficial module experience.

While not discussed during the focus group, there was some evidence from the teaching experience that students may not feel completely comfortable with peers being aware of their own skillset. One student, for example, arranged a code development session with the instructor for his component of the team project. It later became obvious, however, that other members in the team had the skillset that was needed. This student had therefore avoided asking his peers, and instead wished to build his own skillset in the background, aided by the support of his instructor.

The peer review scores play an interesting role in supporting an instructor's evaluation of the team work experience, and particularly, if any marginalisation has taken place owing to the actions of the team members. In the situation of the student making a complaint to the instructor about the participation of another team member, a third team member then scored the student who had complained lower than a student who had admitted to not completing much of the work. There therefore appeared to be some unfair scoring in this situation, which had not been resolved. This therefore provided some evidence that the peer scoring may not be entirely fair in all circumstances. This is the rationale underlying our recommendation for instructor moderation of peer review scores.

Cyber security team work experiences

Here, the results are discussed from the perspective of the teams that were part of the Cyber Security modules, as well as the instructor's perspectives on the delivery and outcomes. The profiles of the students from these modules who took part in the focus group and single interview are presented in Table 3.

As has been discussed previously, there are various methods available to assign students into groups. As well as the aforementioned self-organisation and geographic-parameter (i.e. timezone) based organisation, there is also skill-focussed organisation. The overriding intention has always been to create groups that knit and work together well, with a good balance of skills and knowledge. The method of group creation has often had a strong bearing on how well a group works together and meets the above expectations.

Skill-based organisation relies on some knowledge of the cohort. It tries to organise students into teams based on demonstrated or self-indicated skill sets. Generally, each team should have students with an aptitude for, or competence in, programming, project management, English writing skills, and general administration/ organisation. Unfortunately, it can be quite difficult to find an adequate number of students with these skills to populate multiple groups equally. Instructor experience thus far demonstrates that groups tend to fit into three general categories: excellent, intermediate, and dysfunctional. The outcomes of the interviews for each group in this section have been mapped to the relevant research questions.

Table 3. Profile of Computer Science participants

Student participants	Age bracket (years)	Team size	Team distribution	Team project assessment part 1	Team project assessment part 2	Individual reflection/e-portfolio
Student C (Male)	30–40	Four	UK, Italy, and USA	80	68	65
Student D (Female)	25–30	Four	UK, Italy, and USA	80	68	70
Student E (Female) (interview)	25–30	Four	UK, Ethiopia, Pakistan, and Switzerland	74	53	75
Student F (Male)	50+	Four	USA, Spain, UK, and Greece	94	93	89

Excellent groups

- *In what ways does team work contribute to (your) learning?*
- *In what ways does team work create an online learning community in your module(s)?*
- *What positive experiences have you had while working in/supporting team(s) in your module(s)?*

The excellent groups self-organise, allocate work evenly within the group and assign it to fit with each student's strengths, and demonstrate comprehensive communication, project management, and administration skills. They exhibit maturity in their interactions, respecting each individual's opinions, skills, strengths, and contributions. As Student D commented, '*In general or in the context of what we have applied it to, essentially team work is carrying out an exercise together. So, you just divide the exercise in parts and then everybody just has something to do, a part to do. What happened in our case, our group, is that we naturally gravitated towards our specialisation, so like strong suits, while also, learning from each other and I'm saying this because it's an integral part of teamwork, I think, for me. it's like you, strengthen each other and it may sound cheesy but you kind of do a better job because everybody can just chip in with their strongest suit*.'

Student A (from Computer Science) also commented, '*Teamwork is essentially leveraging the skillsets within the collective to achieve a specific task….I guess it's almost like a bonding or an experience, where you know you complete a task together, so you build friendship and connection between you and your fellow peers. And so, to me that's a sort of component of teamwork, which was unexpected actually I didn't expect to sort of form a bond with this, the team that I was sort of tasked to work with, and that was quite meaningful, and we continue to connect to this day, which is really cool*.'

As both comments illustrate, excellent teams manage disagreements and disputes within the group and rarely need to use the peer review process, preferring to rate each individual equally – demonstrating respect for each other's skills and contributions. Excellent groups may not always be the top graded team in a module, but they are consistently within the top 10% for every module.

- **What negative experiences have you had while working in/supporting team(s) in your module(s)?**

However, even membership of excellent groups has some drawbacks. Comments and feedback suggest that many group members stay in their comfort zone and do not try to stretch themselves – or learn new skills. For example, some students complain in various cyber security modules that they have not had a chance to learn more programming, even though large sections of the course are designed to allow them to do just that. It would seem that an extra few percent on top of the overall grade is more valuable than learning a new skill for some.

Intermediate groups

Intermediate groups are less easy to categorise. They are certainly less consistent than the excellent groups and may have a less-than-optimum mixture of skills and/or geographic distribution of members. Although intermediate groups may get the best grades in a single module (where their skills mix is a good fit, for example), they are less consistent across multiple modules and activities and often have different members between modules as well.

- *In what ways does team work contribute to (your) learning?*
- *What negative experiences have you had while working in/supporting team(s) in your module(s)?*

Some intermediate groups can be characterised by a 'hero complex' where one or two individuals own most of the tasks and it is typically their skills that ultimately achieve the intermediate grades. Even though 'heroes' ensure that work gets done, it is not always the best outcome for the team, or even for other individuals in the team. Often some members of intermediate teams know what a team should do, but the team itself does not live up to that standard. As Student F commented, '*My takeaway... is that there's an expectation that a larger task will be broken down into smaller chunks and individuals will perform their portion and then it will come back together. It's usually not like that but that's what the word means to me anyway*.' In intermediate groups, there is also an expectation that some of the members will not contribute, or that their contribution will not be up to the required standard. As Student F mentioned, '*I knew what I was getting into… in most cases I've been the one that pulled an all-nighter and finished a deliverable to get it across the line*.'

'*Some people, step up to (it), and some people don't but you get a lot of junior work from what I've seen even in in this group.*'

The biggest difference between intermediate and excellent groups is evidenced in their peer evaluations. Unlike the excellent groups who respect individual opinions and skills, and apportion equal peer grades

based on that, intermediate groups tend to utilise much more polarising peer assessment scores. Thus, while the excellent groups will almost always apportion equal marks to all group members, the intermediate groups will often demonstrate wildly differing peer grades up to the extreme where some members can score over 90% while others score less than 40% for the same group work.

Dysfunctional groups

- *In what ways does team work contribute to (your) learning?*
- *What negative experiences have you had while working in/supporting team(s) in your module(s)?*

The final category of group is the dysfunctional group. This type of group exhibits the opposite of many of the characteristics of the excellent group: for example, the group may exhibit poor project management and organisational skills; individuals may not attend meetings or respond to messages; the group may not have established a common communication channel; it may also lack one or more key skills such as programming or report writing. As Student F commented, '*I think one problem with a group project is that if you get somebody who chooses not to participate, and they are assigned a group, they still get a mark. Even though you go in and you take marks off at the end, they're still going to pass if your group does well*.' Student E commented, '*The team contract just stated tasks would be allocated but didn't mention who would do what*.' Student E also mentioned that the team had no regular meetings, but just carried on with tasks and communicated when necessary. One member of the team was referred to as the 'coding team member' who did most of the coding for the assessment.

The above comments illustrate the lack of structure, organisation and, in some cases, skills that typify the excellent category of group. One of the main reasons for this, as explained above, is that members of excellent groups tend to self-organise into the same groups for each module, whereas other high achieving individuals will use unofficial or student community networks to form intermediate groups with friends and/or individuals with a history of good grades. This means that people who have not been so successful in previous modules, or do not have core skills such as project management or programming, tend to find themselves outside the excellent and intermediate group 'collectives' and naturally gravitate towards the dysfunctional groups. This ultimately leads to a self-fulfilling failure mechanism.

The focus group conversation also provided some feedback on the use of a peer review grading system. It was felt that the zero-sum scoring did not provide the flexibility the students needed to give meaningful scores to their teammates, with Student D describing it as *'unfair'* and Student C saying there should be an opportunity to *'pick one person in the team you'd like to reward with more marks, like an honourable mention'*. Based on this feedback, we have decided to utilise a new format in the upcoming runs of these modules that is based on a simplified 1-to-5 scoring system (see Appendix 3)

Further instructor reflections – cyber security

Group or team-oriented assessments will often seem like gifts to students who are in 'excellent groups': an opportunity to exercise key strengths, to work in an environment where you are respected and valued and be in a supportive team where you are all learning and working together towards the same goal. It should be the goal of all instructors to encourage such a supportive and valuable learning environment. Unfortunately, it is not always possible, as an excellent computing group requires certain properties: a good mix of key skills including programming, report writing, project management, communication, and organisation. It also requires a certain maturity from the members. These skills are in limited availability within any given cohort. Intermediate groups can still be effective, and provide a supportive learning environment, but only if monitored and supported by the instructor. Dysfunctional groups can lead to destructive and negative behaviours and these kinds of groups should be discouraged and avoided wherever possible.

How can the instructor help in organising and managing online groups? Our recommendation is that the first step is to try and establish a skill-based approach to group setup. The instructor should try and allocate someone with each of the key skills to each group (bearing in mind potential restrictions around location and time zones). In addition, students have asked that instructors attend kick off meetings and assist with initial setup and organisation. Instructors can also help by signposting students to training and resources around key skills such as project management.

A key objective must be to avoid dysfunctional groups. Some of the abovementioned techniques may help with that, but ultimately there may be a need to offer remedial training or coaching, or even to participate more directly. However, if these approaches fail, instructors may need to consider alternative routes and mechanisms to support students who cannot (or will not)

work within team-oriented assessments, particularly as this form of assessment is sometimes critical to a course's learning outcomes. Such alternatives could be a mixture of group and solo work, offering the option of alternative paths through the course, or even a greater emphasis on the e-portfolio assessment, where the student can select which assessments s/he wishes to participate in. In every case, the instructor would still need to emphasise the need for a balance of individual and group-based assessments.

Research Limitations

The research is limited by the relatively small sample size of students participating in the team work experience. However, we justify this as being a preliminary piece of work, the argument of which will be supplemented in future work. Furthermore, we appreciate that qualitative evaluation of the individual performance of groups on a per module basis limits the overall value of team working throughout the entire degree programme, which is a further observation we have come to recognise. In summary, we see evidence across multiple modules that the capable groups continue to work together beyond a single module, with subsequent strong performance across their degree programme. We plan to investigate this finding further in our future work.

Conclusion

There is a need to encourage the development of team-working skills in HE delivery. This becomes particularly problematic when the HE programme is an online master's in computing that is attended by students of varying abilities and in various locations across the globe. The fact that there is limited research covering this area has motivated this case study-based research on the outcomes of team-based projects on such programmes. This study provides information on a pedagogical design for team-based assessments for online programmes, and then presents quantitative and qualitative outcomes of the implementation. We justify this as being significant today given the continual move to online education.

The quantitative outcomes (module scores) are positive overall, and the qualitative outcomes (both from students and instructors) highlight requirements for creating these teams and the need for instructor oversight (as described in the reflections of the instructors involved). It should be noted that one key shortcoming of this research is the number of students involved in the focus group (6 participants out of a total number of 81 students taking the modules in question). However, the instructor perspective in this study has been included to bring into play comments and actions from other students who did not take part in the study, as well as for providing a practitioner's view on the delivery.

One challenge with online learning is the fact that students do not always wish to participate in a synchronous manner. They join the online learning experience as a result of the flexibility it can bring, allowing study to take place around a full-time job and a family. There are benefits, nonetheless, of being engaged in a more synchronous manner. This fact is particularly true for students who have not necessarily opted into the online and distance education model but have been forced as a consequence of circumstances beyond their control (such as COVID-19). The groupwork mode, to some degree, 'forces' students to function in a more synchronous way, allowing the subsequent benefits to be achieved. This can be seen in the quantitative and qualitative outcomes provided in this study.

Finally, the insights from the instructors in this study highlight key 'Do's and Don'ts' (recommendations for organising and managing online groups, as well as moderation of their scores). These should be considered when using any pedagogical design for team assessments, particularly where online delivery is concerned. Team composition, instructor participation, and peer review scoring formats play key roles and will need to be reviewed with each cohort and the mode of delivery.

References

Chang, Y., & Brickman, P. (2018). When group work doesn't work: Insights from students. *CBE Life Sciences Education*, *17*(3), ar52. https://doi.org/10.1187/cbe.17-09-0199

Chapman Learning Commons. (2016). *Working in groups* [YouTube channel]. YouTube. Accessed January 16, 2022. from https://www.youtube.com/watch?v=CIp_kFR5_jc&t=91s.

Cheryan, S., Master, A., & Meltzoff, A. (2015). Cultural stereotypes as gatekeepers: Increasing girls' interest in computer science and engineering by diversifying stereotypes. *Frontiers in Psychology*, *6,* 49. https://doi.org/10.3389%2Ffpsyg.2015.00049

Chiriac, E. (2014). Group work as an incentive for learningstudents' experiences of group work. *Frontiers in Psychology, 5*, 558. https://doi.org/10.3389/fpsyg.2014.00558

Falls, I., Bahhouth, V., Chuang, C., & Bahhouth, J. (2014). . *Sage Open*, *4*(1), 1-9. https://doi.org/10.1177/2158244014525415

Fini, E. H., Awadallah, F., Parast, M. M., & Abu-Lebdeh, T. (2018). The impact of project-based learning on improving student learning outcomes of sustainability concepts in transportation engineering courses. *European Journal of Engineering Education*, *43*(3), 473–488. https://doi.org/0.1080/03043797.2017.1393045

Freeman, S., Theobald, R., Crowe, A., & Wenderoth, M. (2017). Likes attract: Students self-sort in a classroom by gender, demography, and academic characteristics. *Active Learning in Higher Education*, *18*(2), 115–126.

Gardner, B. S., & Korth, S. J. (1998). A framework for learning to work in teams. *Journal of Education for Business, 74*(1), 28–33. https://doi.org/10.1080/08832329809601657

Hiter, S. (2021). What are CIOs looking for in current IT grads? Accessed January 22, 2022. https://www.cioinsight.com/careers/traits-cios-are-looking-for-current-it-grads/.

Hosam, Al-S., & Noria, S. (2018). A systematic review of cloud computing tools for collaborative learning: Opportunities and challenges to the blended-learning environment. *Computers & Education*, *124*, 77–91. https://doi.org/10.1016/j.compedu.2018.05.016

Huisman, B., Saab, N., van Driel, J., & van den Broek, P. (2017). Peer feedback on college students' writing: Exploring the relation between students' ability match, feedback quality and essay performance. *Higher Education Research & Development*, *36*(7), 1433–1447. https://doi.org/10.1080/07294360.2017.1325854

Morrison-Smith, S., & Ruiz, J. (2020). Challenges and barriers in virtual teams: A literature review. *SN Applied Sciences*, *2*, 1096. https://doi.org/10.1007/s42452-020-2801-5

Olaniyi, N. (2020). A survey on the use of e-Portfolios as a form of assessment in online computer science courses. In M. H. Miraz, P. S Excell, A. Ware, S. Soomro, M. Ali (Eds.), *Emerging technologies in computing. iCETiC 2020. Lecture notes of the institute for computer sciences, social informatics and telecommunications engineering* (p. 332). https://doi.org/10.1007/978-3-030-60036-5_19

Maimbo, H., & Pervan, G. (2005). Designing a Case Study Protocol for Application in IS Research. Pacific Asia Conference on Information Systems. Accessed 22 January 2022. https://espace.curtin.edu.au/handle/20.500.11937/45440 .

Peterson, A., Beymer, P., & Putnam, R. (2018). Synchronous and asynchronous discussions: Effects on cooperation, belonging, and affect. *Online Learning Journal*, *22*(4), 7–25. https://doi.org/10.24059/olj.v22i4.1517

Pursel, B. (n.d.). Groups vs. teams. Accessed January 22, 2022, from https://sites.psu.edu/schreyer/groups-vs-teams/.

Quality Assurance Agency for Higher Education (QAA). (2019). Subject benchmark statement: Computing (Master's). Resource document. Accessed January, 22 2022, from https://www.qaa.ac.uk/the-quality-code/subject-benchmark-statements/computing.

Race, P. (2001). Assessment Series No.9: A briefing on self, peer and group assessment. Resource document. Learning and teaching support network. Accessed January 16, 2022, from https://phil-race.co.uk/wp-content/uploads/Self,_peer_and_group_assessment.pdf.

Riebe, L., Roepen, D., Santarelli, B., & Marchioro, G. (2010). Teamwork: Effectively teaching an employability skill. *Education + Training*, *52*(6/7), 528–539. https://doi.org/10.1108/00400911011068478

Russo, D. & Stol, K. -J. (2022) Gender Differences in Personality Traits of Software Engineers. IEEE Transactions on Software Engineering, vol. 48, no. 3, 819-834.https://doi.org/10.1145/2955110

Smith, G., Sorensen, C., Gump, A., Heindel, A., Caris,

M., & Martinez, C. (2011). Overcoming student resistance to group work: Online versus face-to-face. *The Internet and Higher Education*, *14(2)*, 121–128. https://doi.org/10.1016/j.iheduc.2010.09.005

Teaching and Learning Services. (2018). Using peer assessment to make teamwork work. Resource document. Teaching and learning services, McGill University. Accessed January 24, 2022. https://www.mcgill.ca/tls/files/tls/tls-group-peer-assessment-resource-doc-oct-2018.pdf.

Teaching and Learning Services. (2021). Designing peer assessment assignments. Resource document. Teaching and learning services, McGill University. Accessed January 26, 2022, from https://www.mcgill.ca/tls/files/tls/tls_designing_peer_assessment_assignments_-_march_2021.pdf.

The Chartered Institute for IT (BCS). (2020). Guidelines on course accreditation information for universities and colleges. Resource document. Accessed January 22, 2022, from https://www.bcs.org/media/1209/accreditation-guidelines.pdf.

Thorn, M. (2020). Are group assignments effective pedagogy or a waste of time? A review of the literature and implications for practice. *Teaching Public Administration*, *38*(2), 257–269. https://doi.org/10.1177/0144739420904396

Tucker, R., & Abbasi, N. (2016). Bad attitudes: Why design students dislike teamwork. *Journal of Learning Design, 9*(1), 1–20.

University of Waterloo. (n.d. - a). Centre for teaching excellence—Making group contracts. Accessed September 16, 2021, from https://uwaterloo.ca/centre-for-teaching-excellence/teaching-resources/teaching-tips/developing-assignments/group-work/making-group-contracts.

University of Waterloo. (n.d. - b). Centre for teaching excellence—Methods for assessing group work. Accessed September 24, 2021, from https://uwaterloo.ca/centre-for-teaching-excellence/teaching-resources/teaching-tips/developing-assignments/group-work/methods-assessing-group-work.

Vera, F. (2021). Considering the effects of computer scientist stereotypes on mental health. *IEEE Technology and Society Magazine*, *4*0(3), 53–59. https://doi.org/10.1109/MTS.2021.3104403

Vivian, R., Falkner, K., & Falkner, N. (2013). Analysing computer science students' teamwork role adoption in an online self-organised teamwork activity. In *ACM International Conference Proceeding Series* (pp. 105–114). https://doi.org/10.1145/2526968.2526980

Vogler, J. S., Thompson, P., Davis, D. W., Mayfield, B. E., Finley, P. M., & Yasseri, D. (2018). The hard work of soft skills: Augmenting the project-based learning experience with interdisciplinary teamwork. *Instructional Science, 46(3)*, 457–488. https://doi.org/10.1007/s11251-017-9438-9

Wildman, J., Nguyen, D., & Duong, N. (2021). Student teamwork during COVID-19: Challenges, changes, and consequences. *Small Group Research, 52*(2), 119–134. https://doi.org/10.1177/1046496420985185

Wilson, K., Brickman, P., & Brame, C. (2018). Group work. *Life Sciences Education*, *17*(1), 1-5. https://doi.org/10.1187/cbe.17-12-0258

Yin, R. (2017). *Case study research and applications: Design and methods*. Sage.

Appendixes

Appendix A: Interview Questions used for Student Focus Groups/Interviews

Demographic information (requested prior to interview)

1. Age band (years) (18–24, 25–34, 35–44, 45–54, 55–64, ≥65)
2. Gender
3. Prior experience working in a team (Educational or Professional) (years) (0–2, 3–5, >5)
4. Programme name (Computer Science – MSc, PGDip, PGCert; Cyber Security – MSc, PGDip, PGCert)
5. Module(s) in which you have been part of a team:
6. Module length(s) (weeks):

Core Questions

The areas for consideration during the interview are:

1. What is the meaning of teamwork for you?
2. Prior to this module/team assignment, if you had the choice to work within a team or individually, which would you choose?

Research Question 2: In what ways does teamwork create an online learning community in your module(s)? Applicable questions:

3. (Related to practical aspect around the team work)
   a. How was the team composed?
   b. How did you use the team contract? How did you team use role assignments? Was there a team leader?
   c. How did your team communicate?
   d. How regularly did you meet as a team and how were the meeting minutes recorded?
   e. What was your role in the team discussions?
   f. How did you use the peer evaluations and ratings?
   g. Did you have any strategies that your team used for a successful group work?

4. Did experiences in your wider life impact your ability to participate in the teamwork experience?
5. What qualities are essential in students to support an effective teamwork experience?
6. What role should a tutor play in supporting an effective teamwork experience?

Research Question 3: In what ways does teamwork contribute to (your) learning?

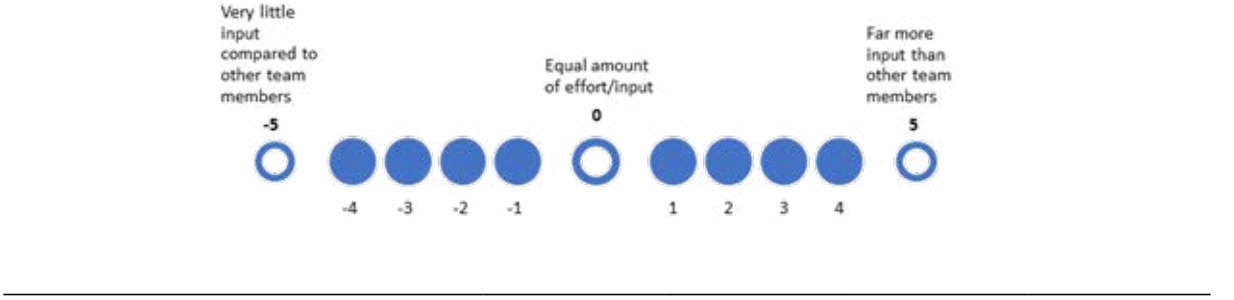
Research Question 4: What positive experiences have you had while working in/supporting team(s) in your module(s)?

Research Question 5: What negative experiences have you had while working in/supporting team(s) in your module(s)? Applicable questions:

7. What are benefits and challenges of teamwork in the module(s) you took (specifically, building of an online learning community, and developing your personal learning)?
8. Describe your perceptions now about the team-based activities in relation to your performance in the module(s) – academic and personal
9. With the benefit of hindsight, is there anything you would do differently in relation to your teamwork experience if you were put in the same position a second time?
10. If you could give a recommendation for the next class, what would you like to give?

Appendix B: Peer Assessment/Evaluation Guidelines – Version 1 of Team Evaluation section

Write the name of each of your group members in a separate column. For each person, indicate the extent to which you agree with the statement on the left, using the extended scale below. Leave the score **blank if no contribution** was made, and the total of all your team members' scores should equal 0:



Evaluation criteria	**Team member:**	**Team member:**	**Team member:**	**Team member:**
Attends team meetings regularly and arrives on time.				
Contributes meaningfully to team discussions.				
Completes team assignments on time.				
Prepares work in a quality manner.				
Demonstrates a cooperative and supportive attitude.				
Contributes significantly to the success of the project.				
TOTAL for team members (should equal 0)				

Feedback on team dynamics

1. How effectively did your team work?
2. Were there any behaviours of your team members that were particularly valuable or detrimental to the team? Explain.
3. What did you learn about working in a team from this project that you will carry into your next group/team experience?

Appendix C: Peer Assessment/Evaluation Guidelines – Version 2 of Team Evaluation section

Write the name of each of your group members in a separate column. For each person, indicate the score to which you agree with the statement using the rating scale below. Leave the score **blank if the team member was absent/ did not participate at all**.

Rating scale
1 – Did not contribute in this way
2 – Willing but not very successful
3 – Average
4 – Above average
5 – Outstanding

Evaluation criteria	**Team member:**	**Team member:**	**Team member:**	**Team member:**
Attends team meetings regularly and arrives on time.				
Contributes meaningfully to team discussions.				
Completes team assignments on time.				
Prepares work in a quality manner.				
Demonstrates a cooperative and supportive attitude.				
Contributes significantly to the success of the project.				

Feedback on team dynamics

1. How effectively did your team work?
2. Were there any behaviours of your team members that were particularly valuable or detrimental to the team? Explain.
3. What did you learn about working in a team from this project that you will carry into your next group/team experience?