

Using contributing student pedagogy to enhance support for teamworking in computer science projects

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ABSTRACT

This paper discusses an enhancement project completed at two Universities in the United Kingdom (UK). It is an example of contributing student pedagogy [9], exploring why whilst teamworking is valued by employers, its inclusion is less well received by learners themselves [2, 14, 25]. The work began as part of the Cardiff University Student Education Innovation Projects (CUSEIP) Scheme which provides opportunities for staff and placement students to work collaboratively on learning and teaching projects. The work explores learners' perceptions and experiences of teamworking before and as part of taught courses which are then intercalated into an evolving set of guidelines and used to inform further enhancements. The original guidelines were developed by the CUSEIP student. The approach and outcomes will be of interest to others engaged in the delivery and enhancement of student teamwork within computing related programmes and potentially other disciplines.

CCS CONCEPTS

• **Social and professional topics** → Professional topics; Computing education; Computing education programs; Computer science education.

KEYWORDS

Contributing Student Pedagogy, Teamworking, Project

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1 WHAT IS IT?

It is widely accepted that the ability to work as a team is a crucial skill for successful employment [21] and in the Science, Technology, Engineering and Mathematics (STEM) [20] and Computing [7] careers. However, employers report that graduating computing students are still under prepared in teamwork skills [17] which some students find difficult to learn [5]. It is incumbent on Computer Science departments to prepare students effectively for the workplace by not only including opportunity for teamwork in the curriculum. Coverage of teamworking is mandated by the various professional body accreditation regimes that operate within the computing space in the UK and in other jurisdictions [3]. This paper describes an enhancement project at two universities in the United Kingdom addressing computing learners' perceptions of teamwork as part of assessed activities. The work integrates the exploration of learners' perceptions of working in groups and teams into the delivery, guidance and support of learners completing summative assessed team projects.

The project was completed in partnership with a CUSEIP summer placement student. It involved researching learners' concerns related to Teamworking, the development and deployment of a perceptions survey and the embedding of the results into a set of guidelines. The project was initialized in 2017-18 to develop a shared understanding and agreement of appropriate behavior of individuals and team members in a team. In the first stage of the project the CUSEIP student ran forums with current students and staff to identify their concerns and expectations of behavior in a team. This information was used to influence the design and development of a pilot survey deployed to explore learners' perceptions of assessed teamwork at Cardiff University. The CUSEIP student used the survey results, feedback from the forums and a related literature review to inform the development of a code of conduct and a set of student-focused guidelines for learners completing assessed teamwork. The guidelines recommendations enable learners to develop their own teamworking agreements setting out expected behaviors for working in the team, including encouraging students to value the contributions of others. In 2018-19, the guidelines and supporting workshop were rolled out across the School for most modules involving teamwork.

Following discussions with Northumbria University, the universities collaborated on an enhanced project for 2019-20. The guidelines were introduced in taught seminars following an initial discussion on learners' prior teamworking experience. Learners completed a survey on their experience and perceptions of teamworking as a catalyst for these discussions. The learners developed their own team agreement for each team, based on the guidelines. The cohort's responses to the survey were discussed, again at a seminar, as a way of surfacing student views and promoting a discussion regarding positives and challenges of teamworking. At the end of each module, learners completed a second survey providing insights into how the teamwork has progressed and how it has been supported. The surveys have been ethically approved by appropriate university processes. All learners are asked to consent to the use of their responses for the further development of support mechanisms and external dissemination / publication as a question within the surveys.

2 WHY ARE YOU DOING IT?

Computer Science learners' perceptions of teamwork have not commonly been explored. This project employs contributing student pedagogy [9] to develop and enhance the processes related to supporting computer science team projects. This enhances the support mechanisms and the understanding of the challenges faced by learners in computer science team projects. At Cardiff University, no central guidelines existed with respect to team working. At Northumbria University, there is university level assessment policy and related guidelines which have been helpful in promoting good practice in the support of learners completing assessed group activities. Whilst all education and teaching of teamwork has its challenges [1, 8, 14], there are some unique challenges related to supporting teamwork related to computing / computer science education [8, 10]. As is commonly the case in the computing discipline, the teamworking in this study involved the creation of artefacts linked in some way to the software development lifecycle. This, by its nature, has differing challenges to collectively writing a report or preparing a presentation or so on.

3 WHERE DOES IT FIT?

One key difference is Peer Assessment is employed at Northumbria University; however, it is not employed at Cardiff University. At the Cardiff University the modules operated in a year-long manner. At the Northumbria University the modules were delivered in a semesterised manner with the modules all being delivered in the second semester between January and June 2020. All the modules are taught to students as part of BSc (Hons) Computer Science programmes and involve project-based learning. In brief the modules are described next. At Cardiff University, the first-year module Developing Quality Software (Dev Software) is taught to about 180 learners. The team size adopted is 6 selected by the module leader. The focus is introductory software engineering with a focus on quality, including basic UML modelling, implementation, and testing. The students are assessed as a Team (without peer assessment) through an initial requirements document, a design document, and presentation of the implemented system and individually through a reflective report. The first-year module Systems Analysis (Sys

A) is taught to about 200 students. The focus is introductory software engineering, user research and basic UML modelling. It is assessed by a project (team component 50% and individual contribution 50%) and related presentation (20% team component and 80% individual). At University Two, the final year undergraduate module, Team Project and Professionalism (Team Project) which is taught to about 160 learners. This capstone provides a case study to explore professional, ethical, legal, social issues as well as to explore the commercial and security issues related to the developed prototype and its future potential commercial exploitation. It is assessed by a proposal (50% team, 50% individual), a practical project (20% team, 80% individual) and an evaluative report (100% individual). At Northumbria University, in both modules, the adopted team size is 5 and learners complete a self-selected project, including live research.

4 DOES IT WORK?

Table 1 provides some insights into the responses by cohorts at each university to the second survey deployed at the end of the module

A Chi square test for independence, suggests student engagement on task ($\chi^2(10, N=263) = 38.99, p < 0.001$) and student contribution to task ($\chi^2(10, N=254) = 33.02, p < 0.001$) are dependent on the module studied. This suggests that enhancements by module may be in order. A Chi square test for independence, suggests the extra support requested is not dependent upon the module studied at Northumbria University ($\chi^2(5, N=331) = 5.90, p = 0.68$). However, a Chi square test of independence, suggests the extra support requested is dependent upon the university the module is studied at ($\chi^2(5, N=391) = 31.57, p < 0.001$). This suggests some local enhancements could be beneficial at both universities. However, the delivery of the final stages of all three modules was disrupted by a sudden move to online delivery due to Covid-19. This was a theme commonly highlighted by learners. Such challenges included: adapting to working remotely; related to access to study for themselves or a peer (technology or internet access); disruption by moving 'home'; and self, or peer illness. Several learners requested more help with version control. Some learners highlighted that the lack of working in a team in the lab impacted their progress. At Cardiff University, the implementation assessment had been released for 3 weeks when there was a move to online, whereas at Northumbria University, the assessments had been released for 8 weeks. Equally, response rates between the modules may be a contributing factor. At Cardiff University, in the teams reporting issues with at least one member of the team, 25 out of 31 students mentioned that they had little or no engagement with the team agreement after the start of the project. For the academic year 19/20 the project associated with the module being discussed here was combined with the assessment for another module. The structure of the assessment within this second module affected the organization of the teams and may be reflected in the survey results. These delivery differences may have had an impact.

When asked if learners had "experienced or witnessed any conflicts within your group, you perceive were relating to gender, sexuality, religion, race, identity or nationality", a tiny minority reported they had. Each module had one student indicated they had conflict

Table 1: Survey Responses

	Dev Software	Sys Analysis	Team Project
Response rate	41/180	139/209	110/164
How effective was your team in managing the following tasks: coordination, tracking progress and group meetings?			
	Number of responses (% of respondents)		
Not well, could have worked more effectively	6 (17%)	2 (1%)	11 (10%)
Not well but was still able to work effectively	7 (20%)	11 (8%)	10 (9%)
Tasks seemed to be managed well but it was not effective	14 (39%)	20 (14%)	13 (12%)
Tasks were managed well, and it was effective	8 (22%)	104 (75%)	71 (65%)
Other	1 (3%)	2 (1%)	5 (4%)
To what extent did team members engage (e.g. attended meetings, participated in discussions, etc) in the project?			
All team members engaged equally.	5 (14%)	55 (40%)	24 (41%)
All team members were engaged, with one or two team members to a greater extent	7 (20%)	43 (31%)	20 (18%)
Most engaged but one or two was very limited.	16 (44%)	34 (25%)	27 (25%)
Only one or two team members were fully engaged.	6 (17%)	1 (<1%)	10 (9%)
All team members did not engage or had limited engagement	1 (3%)	0 (0%)	0 (0%)
Other	1 (2%)	5 (3%)	8 (7%)
To what extent did team members contribute to the project deliverables?			
All team members contributed equally well.	6 (17%)	57 (41%)	50 (45%)
Team members contributed fairly, with one or two contributing to a greater extent.	15 (42%)	57 (41%)	32 (29%)
Most contributed but one or two contributed noticeably less.	7 (20%)	21 (15%)	18 (16%)
All could have contributed more.	2 (6%)	1 (0%)	0 (0%)
Other	6 (17%)	3 (2%)	10 (9%)
Do you think you would have benefited from more guidance on any of the following issues before your group project had commenced?			
Coordination and delegation of tasks	15 (42%)	26 (18%)	19 (17%)
Team discussions and meeting	7 (20%)	10 (7%)	16 (15%)
Team Roles	14 (39%)	18 (13%)	20 (18%)
Group Project Planning	16 (44%)	20 (14%)	26 (24%)
Team communication	5 (14%)	15 (11%)	17 (17%)
Other (Commonly Covid-19 related)	2 (7%)	27 (12%)	4 (4%)
Did not need more guidance	5 (14%)	82 (59%)	62 (56%)

and not reported it. However, two students in Team Project and one student in Dev Software indicated they had reported conflicts, but it was investigated to their satisfaction. For the next delivery, the guidance for the construction of the team agreement will be updated to explicitly signpost the available mechanisms. On reflection, the survey question was too broad and may have conflated issues and hence potentially hid uncomfortable truths [2], this will be addressed for the next iteration. The guidelines, specifically the team agreement, is part of the solution as the student on Dev Software referred to this document when reporting the issue.

At both universities, the perception of the academics was that the team agreement [14] helped the formation of the teams resulting in fewer teamwork issues and most importantly more effective engagement at the start. The severity of the impact of the circumstances related to Covid-19 and differing response rates aside, the other main difference in practice between the two universities is the use of peer assessment at Northumbria University. The differences in the responses from students suggests that this is effective at promoting engagement from the full team.

5 WHO ELSE HAS DONE THIS?

Project-based learning is not a new idea and arguably builds on early work related to experiential learning by John Dewey [4]. Developing teamworking skills is a curricula element that requires careful thought to implement to address a number of challenges including: preventing social loafing (free-riding, free-loading, passengers and related terms) and using assessment appropriately [18]; design to encourage collaboration [24]; clear individual accountability [1] and use of a learning agreement / contract [11, 12, 14], and differing gender behaviors [10].

Contributing student pedagogy [9] has been used to explore learners' perceptions of team assessment regimes [16, 19], however how it can be used to enhance teamworking guidance and procedures has been less frequently explored.

The placement student acknowledged the influence of Daniel Levi [13] in developing the guidelines. Other sources are cited in the guidelines including work on developing a team contract [11] and managing problem behavior [22]. The student framed the work into the computing context and embedded findings from her survey to highlight key issues that the guidelines addressed.

The work is also consistent with the practical advice related to computer science project work [5] which suggests key factors may include: good group self-management (which the guidelines promote); a suitable technical level; "real" projects, (which is the case at Northumbria University); and the willingness to gradually transfer control and responsibility for learning from tutors to learners. The use of contributing student pedagogy is evidence of this. Other suggested strategies to promote effective team working have included: redesigning the early part of delivery to incorporate team training and building [23]; advising on best practice, including team challenges and reflecting upon experience [5, 6], (although team challenges and games may neglect learners taking responsibility for participation); and use of upfront peer evaluation to better understand opportunities and obstacles [12].

6 WHAT WILL YOU DO NEXT?

There are several avenues for further work. Given the current blended learning approach in the UK there is a need to strengthen support regarding remote working. The teamwork guidelines will be revisited to reflect the information provided by learners at that institution, particularly important for Northumbria University to further emphasize to learners the relevance of the guidance to their place of study. The feedback from learners at both universities suggests that there is a need for further support in terms of handling social loafing which remains a challenge [18], that peer assessment partly addresses. Further work is also needed to encourage teams to adapt the Team Agreement over the course of the project, so it becomes a living document, which is particularly for longer projects. Finally, whilst the guidelines promote respectful and inclusive behavior, they fall short of emphasizing the benefits to productivity and innovation that diverse teams promote [15], the intention is to update the guidelines to signpost and promote these benefits.

7 WHY ARE YOU TELLING US THIS?

The work provides a case study of using Contributing Student Pedagogy to enhance teamwork support. Students were keen to engage with the CUSEIP student to share their concerns and expectations, which gave valuable insight into developing the guidelines for team-working. Learners developing team agreements have been found to be an effective approach to help teams form and prevent team issues particularly at the early stages of a project. Whilst it does not fully prevent social loafing, use of peer assessment has a positive impact on team contributions and a reducing in perceived social loafing. Whilst this work has been completed in Computer Science these practice recommendations apply equally to other disciplines.

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