WHAT ARE GOOD TEAMWORK SKILLS AND HOW DO STUDENTS LEARN THEM?

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Conference Key Areas: *Challenge based education, Future engineering skills*
Keywords: *teamwork, project-based learning, skills, student reflection*

ABSTRACT

As modern STEM programmes move to focus on a more skills based curriculum, a different approach to conceptualising learning is required. Learning skills is a very different process to learning a list of technical information. In the same way that becoming fluent in a language requires more than learning a list of vocabulary.

Curricula are addressing this by moving away from solely using knowledge transfer methods and including multiple experiential learning experiences. These experiential learning experiences allow students to recontextualise existing knowledge, add experience or tacit knowledge to their learning and practise professional skills such as problem solving and communication skills repeatedly. [1] [2]

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For teamwork skills in particular, how student learn skills in this context is somewhat like a black box. [3] We hope that by opening the box lid, with the introduction of student self-reflection, we have increased the effectiveness of experiential learning experiences. Here we start to analyse these self-reflections to better understand the student team process in order to better support students in their learning.
This paper focuses on the teamwork skills section of our pilot study. We asked Chemical Engineering students to reflect on their teamwork experiences. We present some initial findings on student's ideas on teamwork skills and what they have learnt in their teamwork projects. Our findings show that students have a relatively broad view of what teamwork skills are and readily engage in the reflective practise needed to improve those skills.

1 INTRODUCTION

1.1 Adapting Engineering Education to a New Job Market

New engineering graduates are entering an employment market that is increasingly flexible and because of that, skills focused. Regularly published top ten lists of what skills employers are looking for consist almost exclusively of professional or soft skills rather than technical knowledge [4]. The question of how engineering curricula evolve to meet this challenge and prepare graduates for this new market has been discussed at length. Many leading institutions in engineering education have developed and implemented ambitious new curricula and incorporated new teaching methods [5].

One aspect of this is the move to a skills focused approach. Students are provided with multiple opportunities to acquire and practise the skills that regularly crop up in those top ten lists. Students work on group projects to learn teamwork, leadership and delegation. They present to each other improving their technical and non-technical communication skills as well as providing feedback to others. We ask them to produce design proposals and prototypes, on paper and in 3D, to get them familiar with the design process and improve their problem solving and practical skills.

1.2 Why do Skills Need to be Taught Experientially?

For many the need to teach a skill through repeated facilitated practice rather than the traditional knowledge transfer methods seems obvious. To learn a skill, you must practise a skill multiple times to properly understand it. Two concepts can help to us to understand why, recontextualisation of knowledge as discussed by Guile [1] and tacit knowledge, a catch all term used by many but for the purposes of this paper as articulated by Collins [2].

Guile's recontextualisation theory states that knowledge is not learnt once and never changed [1]. A piece of knowledge is not only the information contained in it but also every context that someone has used it in and the connections to other pieces of knowledge. The information contained in an organic chemistry textbook means one thing to a chemist and something different to a pharmacist because they bring the

context in which they use the knowledge to its understanding. Thus every time we use a skill we are recasting it in the context in which we are using it. Hence why we need to repeatedly use a skill to fully understand it.

Tacit knowledge as articulated by Collins was proposed to reconcile the fact that not all information on a scientific method could be included in a written account [2]. There is information that can't be expressed in a written account, for example local knowledge or information that is deemed inconsequential. In applying this idea to skills, becoming proficient at a skill requires a combination of theoretical knowledge and experience because learning a skill is more than learning a list of information.

A key aspect of improving our teaching practise is to understand how students are learning skills, to 'lift the lid' on student learning and use that information to inform and improve our practise [3]. The aim of our longitudinal study is to provide some insight into how student's learning progresses over time. The first step is to understand what students think teamwork skills are. We have used data from students' self-reflections on teamwork which they completed as part of their assessment for a team project. The self-reflections, the peer feedback they are in part based on, have been incorporated into teamwork assessment to walk students through the experiential learning cycle [7]. Previous work has used self-reflection to look at students' perceptions of how their skills have developed [8]. In depth discussion of the use of reflection can be found the literature and isn't the focus of this paper. Here we present some initial findings on students' conception of teamwork skills and what they learnt during teamwork.

2 METHODOLOGY

2.1 Project Work

First year Chemical Engineering undergraduate students are placed in groups of 5 or 6 and asked to work on a project over the course of a week, called a scenario [6]. Over the week, each team has various deliverables that they need to complete. As part of the assessment of the project, students are asked to complete a structured teamwork reflection individually. These are marked as pass/fail based on whether students complete the reflection. A sample of these reflections form the data set for this paper.

2.2 Data Analysis

Ninety-four students completed the reflection online in our online learning space and that data was extracted and anonymised before analysis. We used a thematic analysis of the data. The two questions we have analysed are *What Are Your Main Strengths?* and *What Did You Learn?*. To provide a structure for coding for the first question, coding was based around a list of teamwork skills from an undergraduate teamwork study guide [9] The. list contains a one or two sentence definitions of teamwork skills which was then converted into the one or two word phrases seen in table 1. Responses were categorised based on the skill definitions. As the coding for

the first questions did not fit the responses to the second question, coding was drawn from the data set.

3 RESULTS

3.1 What are Good Teamwork Skills?

Levin, in his study guide for undergraduate students on teamwork, when talking about the somewhat abstract idea of teamwork skills, provides two lists of skills, intellectual and emotional [9]. For him, the primary difference between intellectual and emotional skills being whether or not they can be taught in a classroom; the former can while the latter one can only learn through experience. Given the concepts of recontextualisation and tacit knowledge outlined previously, this difference seems very artificial but the list of skills does provide a starting point for analysing students' thinking on teamwork skills.

Below, in Table 1, are the results from coding the students' reflections on the question *What are your Main Strengths?* One important aspect to note is that whilst we have used Levin's teamwork skills as a basis for evaluating the student reflections, what is clear is that students' definitions of skills vary, with one of the most common being leadership*, "I believe that my main strength is leading a group and delegating roles. … I also think that I am organised, which helps me to be a team leader." Student G*. Under Levin's definitions this would fall into Managerial Awareness rather than Leadership but clearly at this stage of their learning students equate decision making and organisation with leadership rather than the more abstract definition of providing motivation and vision.

Table 1. Number of mentions coded as teamwork skills (for definitions see [9])

Situation Appreciation	1	Empathic Communication	8
Issue Oriented	3	Respectful Communication	22
Project Management	0	Negotiation	1
Research	8	Realistic Task Setting	0
Alternative Sources	0	Social Cohesion	4
Articulate Issues	0	Leadership	7
Objectives and Constraints	0	Team Support	8
Transferability	0	Facilitation	4
Team Feel	0	Collective Participation	0
Personal Resilience	1	Managerial Awareness	6
Social Sensitivity	1	Team Responsibility	2
Reflection	0	Other	31

The largest category is Other, which covers anything students have referenced that is not covered in Levin's skill set, including skills such as punctuality, work ethic, confidence, working under pressure - personal qualities which may make working in

a team easier but are much broader skills that are useful in a range of contexts. In particular, time management and meeting deadlines are mentioned a lot, not just within Other, but both are frequently referenced alongside other skills. However, the majority of references are in relation to the student only, *"My main strength would be I can always finish my work on time" Student AV*. Given more data from subsequent student projects or from student interviews, we may be the beginning of learning teamwork skills such as, Managerial Awareness, or Team Responsibility, or we may find that this coding structure needs to be modified to better reflect students' thinking.

Communication is a key skill for students, with the two communication categories, seeing the same number of mentions as Other. Students clearly feel that being able understand other team members' viewpoints as well as clearly communicate their own ideas is very important to successful teamwork.

Interestingly, skills such as Social Cohesion, Leadership and Team Support, skills that typically have a significant social aspect to them, are mentioned several times by students; noteworthy given the stereotype of the engineer as lacking in social skills.

3.2 What Did You Learn?

We took a thematic approach to the analysis of this question as students approached it in very personalised way. They mentioned skills that they had discovered or successfully improved as well as those that they had identified that need improvement in the future. Table 2, shows the main themes drawn from this data set.

Table 2. Skills that students have either improved or need to improve

Take Initiative	4	Confidence	12
Work Ethic	8	Punctuality	6
Organisation	4	Resilience	2
Balance	1	Big Picture View	4
Presentation Skills	3	Team Support	12
Communication	29	Leadership	6
Trust	2	Interpersonal Skills	8
Non-Specific	15		

A common theme in the reflections is that students had not realised that they had a particular skill or that their peers had recognised their efforts, *"I was surprised that [they] used this term [in the peer feedback] as I didn't think I was showing this skill" Student BG*. Students also mentioned that this reflective process was useful, *"This feedback made me take a step back and evaluate the week's work and how I have participated and worked" Student BM*.

Communication is a key area that students felt that they had either improved in or needed to improve it to work better within a team. This is part correlates with the previous question where communication skills were a common teamwork strength that students identified. Another key area that students identified are Interpersonal Skills and Team Support, again correlating with the previous question.

4 SUMMARY

Our initial results show that students have a relatively nuanced view of team skills in their first year of undergraduate study, with mentions of a broad range of skills. There are some clusters in areas such as Communication and Work Ethic but it is satisfying to see some understanding of the social aspects of team work, with mentions of more social focused skills, such as Social Cohesion and Team Support, bucking the stereotype of the engineer with limited social skills. Students found the teamwork experience and the structured reflection useful and were able to identify what worked and what needed improvement, hopefully feeding into the experiential learning cycle. Further work is need to gain insight into students' learning over time by linking students' progression over multiple project work experiences as well as increase the nuance our analysis to better reflect students' understanding of teamwork skills.

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