'Soft' skills identified by students who peer-led mathematics computing workshops

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Abstract

Increasingly, employers are suggesting that 'soft' skills, such as communication and teamwork, are equally important as 'hard' skills, such as discipline specific knowledge. This makes it imperative for university programs to build in opportunities for students to practise and demonstrate such soft skills. For some years, small groups of students in my second-year numerical methods course have acted as peer-leaders, with each student taking a turn to help run the computer workshops. In 2018, I introduced a PebblePad reflection to give the students the opportunity to identify the skills that they had developed, as well as to reflect on the process. In analysing the students' responses, I found that the students were very positive about the experience and that they were able to articulate a range of soft skills that they had practised and developed during the activity.

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Contents

1 Introduction

Increasingly, Australian employers are saying that they require graduates with communication, teamwork and problem-solving skills [6]. According to a recent report into the future of work for Australian graduates [10], skills such as critical thinking, creativity, problem-solving, leadership and people management are just as important as technical skills, and will become more so into the future. Also, a study of business leaders in the United States found that 75% of job success in the long-term can be related to people skills, compared with 25% to technical knowledge [9]. The non-technical skills, knowledge and attributes are the factors that allow employees to successfully function in the workplace [6].

Technical skills are often referred to as 'hard' skills, while non-technical skills are sometimes referred to as 'soft' skills, human skills, transferable skills, employability skills, enterprise skills or capabilities [2]. There are many lists

Table 1: List of 'soft' skills.

Adaptability	Communication (written, verbal)	Creativity & Curiosity
Critical thinking	Cultural awareness	Empathy
Emotional intelligence	Ethical judgement	Innovation
Leadership & Initiative	Organisation & Time management	People management
Perseverance	Problem-solving	Teamwork

of soft skills and some are listed below.

For example, Pozzi et al. [11] suggest soft skills include working in a team, thinking critically, problem-solving, and communicating effectively and with confidence, while a 2019 Deloitte report [3] lists self-management, communication, teamwork, problem-solving, critical thinking, innovation, emotional judgement, global citizenship and professional ethics. An Australian study into Biomedical Science student perceptions of transferable skills highlighted communication, teamwork and critical thinking [4]. Looking outside Australia, a 2018 survey of Russian employers identified seven key soft skills for university graduates, many of which overlap with those mentioned above: systems and critical thinking, development and implementation of projects, teamwork and leadership, communication, intercultural interaction, self-organisation and self-education, and health care [7].

A 2017 Deloitte report [2] forecasts that two-thirds of all jobs in 2030 will be soft skill intensive. It also suggests that skills can be broken down into three categories: foundational literacies (literacy, numeracy, and scientific, information and communications technology, financial, cultural and civic literacy); competencies (critical thinking/problem-solving, creativity, communication, collaboration); and character qualities (curiosity, initiative, persistence/grit, adaptability, leadership, social and cultural awareness). A list incorporating most of the above soft skills is in Table 1.

Given the importance of these soft skills, it is clear that university courses need to build in opportunities for students to practise these skills, as well as help students to be able to articulate their skills to employers, along

with examples of how they have developed them. The latter is particularly important because the ability of graduates to evidence soft skills can be linked to an increase in confidence and higher employability [11].

It may be that employability is addressed more explicitly in some university courses than others (for example, in professional courses such as Engineering), but that is not to say that other STEM students are not developing some of these skills in their courses. The important thing is to assist students to become aware of these skills, and this is where a process of reflection can be useful [11].

This article presents the outcome of a skills reflection exercise by students who acted as peer-leaders in a second year computing workshop associated with an applied mathematics course. Students attitudes to peer-leading as well as their identification of skills that they developed are presented and discussed.

2 Learning context

The course is a second-year Numerical Methods and MATLAB course (taught on two campuses) and each of the 2018 and 2019 cohorts consisted of approximately 50 students, of whom about half were Education students, with the remainder being Science (Mathematics and Physics majors), Engineering and Information Technology students. The course is taught in flipped classroom mode [8] via instructor-made videos for lecture content, and there are two hours of class (first hour optional), plus two hours of computer workshops (worth 8%), per week. I first lectured the subject in 2011, including running the computer workshops, and found that it was difficult to give enough individual help to students in the workshops on my own.

So in 2012, I introduced peer-leading by small groups of students. Groups of two or three students each take a turn to complete one workshop ahead of time, with my help if necessary. After meeting with me to check their work, they act as peer leaders in the workshop, with each student in the class

taking one turn as a peer-leader. For example, in 2019 with 20 students on one campus and 30 on the other, there were two leaders per week at the first campus and three leaders per week at the second campus, for ten weeks of the trimester. Students self-select into the groups in Week 1. The assessment for this part of the course requires them to complete a reflection worksheet, which is set up in PebblePad [1]. This takes about ten minutes and students receive full marks (3%) if they take their turn to lead and then complete each compulsory section of the worksheet (the contents are not assessed).

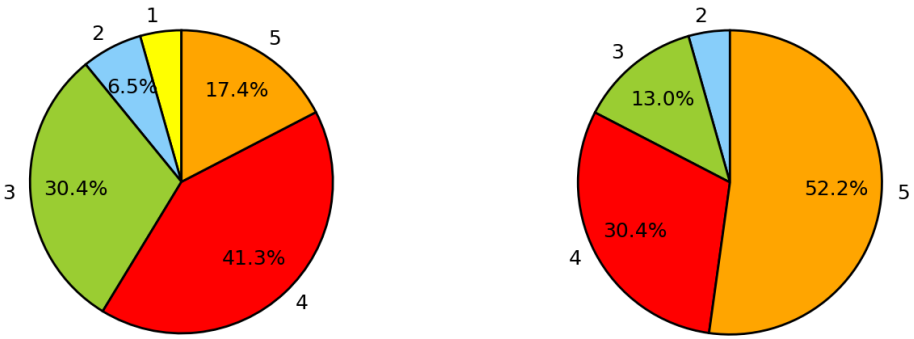
The worksheet has four parts and the last one is optional. The first is a pre- and post-workshop self-assessment on a student's understanding of the material and confidence in leading the workshop. In the second task, they are asked to list in dot-point form non-mathematical things they feel they learned in the process, and the third is another dot-point list, this time of skills and attributes that they feel they developed by acting as leaders. No prompts are given for the lists. Finally, they are given an optional opportunity to make suggestions to improve the workshop.

3 Student opinions

Over the years, student attitudes to acting as peer leaders have been extremely positive, as indicated by (unsolicited) comments in end of trimester University administered surveys and also by the response to the 2019 survey question "The workshop leading in this course assisted my learning" of 4.7 on a 5 point Likert scale, where 5 = Strongly Agree.

In the PebblePad worksheet, students were asked about their understanding of the material and their confidence in acting as a leader. The self-assessment was on a five point Likert scale from 1 = Low to 5 = High. The results for 2019, shown in Figure 1, indicate that students felt their confidence increased after leading, with around 60% of students expressing high confidence (indicated by a score of 4 or 5) prior to leading, compared with around 80% after leading.

[1] www.pebblepad.com.au



(a) Pre-Confidence (b) Post-Confidence

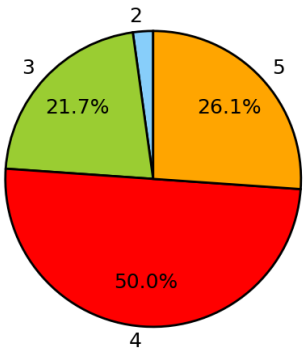
Figure 1: Student 2019 self-assessment of pre- and post-workshop confidence in being a leader. Likert scale: 1 (Low) to 5 (High).

The corresponding percentages for 2018 were 45% and 90%. In a similar fashion (Figure 2), students felt their understanding increased after leading. In this case, the percentage of 4s and 5s increased from around 70% to around 90% for both years. There was also a decrease in the number of 1s and 2s from before and after the workshop, for both questions and years, except for one 2019 student whose understanding remained at 2.

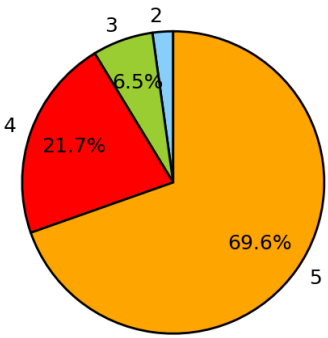
4 Student reflection comments

Some examples of student comments in relation to the question about non-mathematical things that they had learned are given below.

- Students often prefer to struggle silently instead of asking for help right away.
- I started off hesitant with helping my peers, as the class progressed I became more comfortable in the role.
- Acting as a leader gave me more confidence to ask my peers for help when I encounter difficulties myself.



(a) Pre-Understanding



(b) Post-Understanding

Figure 2: Student 2019 self-assessment of pre- and post-workshop understanding of the material. Likert scale: 1 (Low) to 5 (High).

- I am more capable of teaching than I realised.
- How good it feels to help someone understand something they didn't get earlier.
- Different people require different approaches when helping them understand the content.
- There is a difference between understanding the topics and being able to explain the topics to someone else.
- Helping people is a great way to fully understand the material.
- Teaching people difficult concepts is hard. Teaching isn't as fun as I thought it might be.

The student comments were often quite perceptive and indicate that some students realised that they gained personally from the experience. There were quite a number of comments that suggested that the experience allowed them to get to know other students, which improved the class atmosphere.

5 Student identification of skills

Some students simply made a list of skills and attributes they felt that they had developed (as suggested), while others expanded a little more. Some examples are given below.

- To be a good listener. To be friendly.
- Pre-planning/organisation, patience, clear communication/explaining things, adaptability.
- Patience, active listening, ability to explain, time management skills
- Communication, teamwork, leadership, multitasking, respectful, organisation, interpersonal skills.
- How to check for small errors in code. Deeper understanding of how MATLAB runs and how to create better scripts.
- I have developed personal communication skills, teaching skills, patience, and supportiveness.
- My ability at multitasking (listening, explaining and showing how to solve a question).
- Critical thinking—express concepts in different ways (explaining things so other people would understand).
- Encouraging/supportive—even when my peers may not have solved a problem the first time, it was important to be encouraging and guide them through the process.
- How to provide individuals with feedback that lets them solve their problem instead of just giving them the answer.

It is apparent from the above comments that students were able to identify both soft and hard skills that they had developed. In order to summarise the skills mentioned, word clouds were produced from the comments about

Figure 3: Word cloud of skills identified by the 2018 cohort.

Figure 4: Word cloud of skills identified by the 2019 cohort.

skills and attributes (Figures 3 and 4). These were produced by taking the student dot point lists of skills from PebblePad, putting these into a text document and uploading them to the Word Cloud Generator on the web-site https://www.jasondavies.com/wordcloud.

From Figures 3 and 4, it appears that the most commonly identified soft skills were communication, confidence, patience, teaching/explaining, problem-solving and interpersonal skills, such as being friendly, listening, using different approaches and seeing different perspectives. Other skills identified included leadership, organisation, teamwork, trouble-shooting, time-management and multi-tasking.

6 Discussion

Although the main focus of this work relates to student identification of employability skills, one of the results presented in Section 3 was that students felt that their confidence and understanding improved as a result of acting as peer-leaders. A couple of points are worth mentioning in relation to this. Firstly, students completed the worksheet after their turn as a peer-leader, which meant that the pre-workshop assessments were just student recollections of their attitudes before the workshop, and were, therefore, less reliable than if they had been completed beforehand. Secondly, it would, perhaps, be more accurate to say that student confidence and understanding increased as a result of the entire process, not just the actual leading. This was because their understanding increased as a result of a number of factors, such as completing the workshop ahead of time, discussing the results with the instructor, studying harder to try to understand the work because they were nervous about doing it, as well as increased understanding during the class due to discussions with students or other peer tutors, and positive reinforcement during the class when they were successful in explaining work to other students. All this had the effect of increasing their understanding and confidence in explaining the material and hence in being a workshop leader. This effect is consistent with previous research that connects student confidence with

learning and engagement in mathematics, and with persistence in trying to deal with or solve mathematics problems [5, 12].

It can be seen from the word clouds in Figures 3 and 4 that the students have identified many, but not all, of the skills listed in Table 1, although the language used may not be quite the same. Communication skills are rated very highly and this is consistent with the study by Demaria et al. [4] where Biomedical Science students identified communication skills, as well as teamwork and critical thinking, as important transferable skills.

The fact that the students were able to identify most of the skills in Table 1 showed that, as a cohort, the students have a reasonable awareness of employability skills. However, it is not clear from this study exactly how this applies on an individual level, especially as students were not asked to list *all* the skills that they might have developed, nor were they given a list of skills against which to rate their progress, as in the study by Pozzi and Bonson [11]. A possibility for future work might be to give students lists of skills and ask students to rank them in order of importance, as was done for a different purpose by Anthony [1], when analysing factors that influence the success in Mathematics of first year students, or in the study of Russian employers [7] mentioned in Section 1.

Some skills that students did not mention in this study were ethical judgement and people management, which would not be expected in this context, as well as cultural awareness, which perhaps is covered in students finding different ways to approach different students. Others missing are innovation, creativity and curiosity, although the two former attributes are perhaps part of finding different ways to explain material to other students.

Another interesting observation is that the words confidence, multi-tasking and patience come up in the word clouds, but not in Table 1. Perhaps multi-tasking might be regarded as time management, but patience is not mentioned, yet it is high in both word clouds (Figures 3 and 4). However, it makes sense that students might mention patience because they were explaining difficult concepts to other students, as well as helping them to

debug computer programs. Patience is well-known to be a skill that teachers require and teaching is effectively what the students were doing as peer-leaders. It is also reasonable to regard patience as a skill, since the ability to be patient is certainly an attribute that can be developed, in the same way that other character qualities like persistence [2] can be developed.

It is worth noting that confidence is mentioned in a number of contexts: leading the workshop, explaining the material, and in approaching other students. Combining communication and confidence, communicating effectively with confidence is one of the skills listed by Pozzi and Bonson [11]. According to Demaria et al. [4], communication is one of the skills that is highly valued by employers and will continue to be so into the 21st century, and so it is interesting that students appear to be aware of its importance.

As well as providing an avenue for the students to reflect on the experience of acting as a peer-leader, PebblePad reflections also give the instructor a chance to reflect on the exercise. One thing that occurred to me when reading student reflections was that the students had actually practised another soft skill by completing the worksheet—written communication. I also realised that, if one of my aims was for students to be able to articulate skills to employers, then I need to give feedback to the students on what I found. Fortunately, this should be possible as summary reports are a feature of PebblePad and I should be able to produce a word cloud in time for the last class of the trimester, in which there is sufficient time to have a discussion with the class about the results.

7 Conclusions

In summary, students found peer-leading to be a positive experience, and found their confidence and understanding of the content increased. The students were quite perceptive in their reflections and their comments related to a number of different aspects of their experience. Some were personal in terms of how they felt about teaching others, others were insights they gained

about teaching in general, and still others were about differences in learning styles.

Analysis of student responses found that students were able to identify both soft and hard skills that they had practised, although not all students mentioned both types. The most commonly mentioned soft skills were communication, confidence, and patience, while the full list of skills mentioned by students included most of the skills that appear in lists compiled by employers, such as problem-solving, teamwork, critical thinking, organisation, time management and leadership. This indicated that, as a cohort, the students were aware of most of the skills that employers value, and that they were aware of the fact that they were practising some of them in this activity.

In this study, the most frequently listed skills of communication and confidence were referred to in a number of contexts. These included skills and confidence not only in communicating information, but also in ways to approach other students. Students also mentioned that acting as peer-leaders then gave them the confidence to ask their peers for help at a later date.

The other skill most commonly mentioned by students was patience. Their identification of patience as a skill was somewhat unexpected, as it was not in the list of skills compiled from the literature, nor was it mentioned explicitly by the employers discussed in Section 1. However, in the context of teaching, which is effectively what they were doing, it does make sense and it is a skill since it can be improved with practice.

One possible avenue for future work, using these and PebblePad reflections from future cohorts in this course, is to conduct an analysis of the types and numbers of skills mentioned compared with the course that the students are studying. The rationale for this is that it is possible that students studying professional courses such as Education or Engineering may be more aware of soft skills, or employability, because this is dealt with explicitly in their courses.

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