Collaborative problem-solving through asynchronous discussion

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ABSTRACT: The reality of today's workplace for engineers and computing professionals is that the ability to solve ill-defined and complex problems is a much-needed employment skill. The complexity of existing problems dictates that these can rarely be solved by an individual working alone. It is only by working in collaborative teams that such problems can be effectively addressed. This skill, encompassing the common 21st Century skills of problem-solving and teamwork, is often referred to as collaborative problem-solving (CPS). The authors examine the ability of computing students at a UAE university to collaboratively problem-solve through the use of a scenario-based teaching and assessment tool that is delivered as an asynchronous discussion board. It then describes the research method and how the analysis is utilised and discusses the impact of the findings. Results indicate that students performed better in the skill of teamwork when compared to problem-solving, and even though only two groups achieved or exceeded the target mean score for CPS, the overall mean was at the desired target. This suggests there is a need for expanded curricular opportunities for students to work on ill-defined, complex and multidimensional problems in a collaborative group setting.

Keywords: 21st Century skills, assessment, quality assurance

INTRODUCTION

Prior to 2000, educators, policy-makers, economists and a myriad of other constituents and decision-makers had been extolling the virtues of the 21st Century or professional skills and stressing the need that they be more fully integrated into curricula, especially at the tertiary level as this is the last formal education milestone prior to entering the workplace. These skills that often include teamwork, problem-solving, information literacy, leadership, technological literacy, critical thinking and communication, have been seen as critical to employment, because they are skills that transcend traditional disciplinary boundaries and are increasingly what students will be expected to do in the future as the learning of facts has become less important since information and data is more readily accessible. Two of these skills, teamwork and problem-solving, though different, are frequently synthesised to form the overarching skill of collaborative problem-solving (CPS).

Teamwork is commonly thought of as the ability of a group to work together to perform a specific task [1]. Furthermore, the reality of the teamwork construct is that it is rarely conceptualised without completion of a task or more broadly, the solving of a problem. The construct of problem-solving in its most basic form is the process of working towards an implementable solution for a problem. CPS can then be defined as problem-solving actions that encompass interactions between a group of people working as a team [2], but this stated interaction needs to go beyond simple cooperation which can be nothing more than a division of labour. To be truly collaborative, there needs to be meaningful interaction and exchange of ideas amongst members of a team [3]. This conceptualisation of CPS is thought to be at the core of the 21st Century workplace and knowledge economy, because it is rare that large and complex problems can be solved by an individual working alone.

Within the disciplines of engineering and computing the types of problems facing professionals are often ill-defined, complex and multidimensional making it common that engineers and computing professionals work in teams and collaborate in order to solve such problems [4]. The Accreditation Board for Engineering and Technology (ABET) has long recognised this by specifying problem-solving and teamwork as two of the student outcomes to be achieved by students in accredited programmes [5]. Further evidence supporting the assertion of the importance of CPS is found where authors identified the ability to problem-solve is both a core activity and one that is rated with the utmost importance for engineering professionals [6]. In addition, because of the project-driven nature of the computing industry, students who can work effectively with others are more sought-after by employers [7][8]. Such findings

strongly support the notion that the skill of CPS is one that needs to be taught and assessed within engineering and computing programmes to ensure that graduates of these programmes are appropriately prepared for the 21st Century workplace.

Though there is an awareness to the importance of teamwork and problem-solving, the overarching skill, CPS, is often ignored in the curriculum. Opportunities to develop collaborative problem-solving skills are lacking in many courses and curricula because it is believed that teamwork does not necessarily lead to the improvement in collaborative problem-solving [4]. Another author argues that it is not enough that students can …*be assigned to groups with the expectation that social processes will emerge that foster learning. Group activity needs to be set up so that all participants can be active and contributing members* [9]. Collaborative skills require dedicated teaching and assessment as there is little evidence that these skills develop to their full potential otherwise [3]. This research project is aligned with the hypothesis that CPS can be taught and assessed in traditional, tertiary-level computing programmes. This means that the skills can be broken down into component parts as has been done in the instrument utilised in this research, the computing professional skills assessment (CPSA), and more specifically, to levels of performance as is presented in the rubric used in the CPSA. Additionally, it has been shown that people can collaborate effectively in computer mediated settings as our research has confirmed with implementation of the CPSA [10].

The intent of this article is to report on one phase of a multi-year research project into the genre of learning outcomes often referred to as 21st Century or professional skills within the field of computing. Specifically, the authors of this article examine the ability of computing students at a UAE university to collaboratively problem-solve (CPS). Through implementation of the CPSA, a teaching and assessment tool that is delivered as an asynchronous discussion board of a learning management system, the 21st Century skills of problem-solving and teamwork are used to assess the CPS attainment of student groups. In the latter part of the article, the authors describe the CPSA instrument in more detail, clarify how CPS is represented through it, describe the method and how the analysis is utilised, and discuss the impact of the findings. Results indicate that students performed better in the skill of teamwork, when compared to problem-solving, and even though only two groups achieved or exceeded the target mean score for CPS, the overall mean was at the desired target. This all suggests there is a need for expanded curricular opportunities for students to work on ill-defined, complex and multidimensional problems in a collaborative group setting.

RESEARCH QUESTIONS

The two research questions from this phase of the research project look explicitly at the ability of students to problem-solve collaboratively using the teamwork and problem-solving components of the CPSA and to student perceptions of the CPSA task itself.

1. What are the levels of student performance in the skill of collaborative problem-solving?
2. What are student perceptions of the CPSA task in helping them become more proficient in the skill of collaborative problem-solving?

THE COMPUTING PROFFESIONAL SKILLS ASSESSMENT

The computing professional skills assessment (CPSA) is both a teaching tool and an assessment method designed as a learning activity and assessment task for ABET's professional or non-technical skills, specifically the professional skills as defined by ABET's Computing Accreditation Commission (ABET's CAC) prior to 2018-19 version 2.0. Over the past six years, the CPSA has been subject to a continuous improvement process to become a proven reliable and valid method of assessment for both undergraduate and graduate students [11-13]. The CPSA includes, but is not limited to 1) a 1.5 page computing-related scenario; 2) a standardised set of student instructions and discussion questions; and 3) an analytic rubric used by evaluators that includes sections for problem-solving and teamwork. Table 1 presents the ABET Commission's professional skills alongside the CPSA adaptations to better align with the task students undertake when utilising the CPSA.

Table 1: ABET's CAC to CPSA alignment.

ABET's CAC	CPSA
(b) An ability to analyse a problem, and identify and define the computing requirements appropriate to its solution	1) Students problem-solve from a computing perspective
(d) An ability to function effectively on teams to accomplish a common goal	2) Students work together to accomplish a task
(e) An understanding of professional, ethical, legal, security and social issues and responsibilities	3) Students consider ethical, legal and security aspects
(f) An ability to communicate effectively with a range of audiences	4) Students communicate professionally in writing
(g) An ability to analyse the local and global impact of computing on individuals, organisations and society	5) Students analyse the impacts of computing solutions at local and global levels
(h) Recognition of the need for and an ability to engage in continuing professional development	6) Students interpret, represent and seek information

The most obvious adaptation of this sort is CPSA 4, which is focused specifically on writing, because that is the only way in which students communicate during the task. The CPSA itself is a scenario-based on-line discussion in which groups of students work together to propose solutions to an ill-defined, computing-focused problem with no clear solution. Given that teamwork and problem-solving are at the core of the CPSA, the CPSA method is exceptionally positioned to assess CPS.

Sociocultural theory provides theoretical support for the CPSA and the construct of CPS [14]. In sociocultural theory, learning is thought to occur through social interaction. In particular, learning is influenced by meaningful interaction with more advanced peers or mentors. Additional theoretical support is provided to the CPSA through the communities of inquiry (COI) model [15], which has been designed specifically for asynchronous online discussion as deployed in the CPSA. Two of the components of COI are social and cognitive presence. Social presence is the open and honest communication that must occur if a group of people are to work together effectively, while cognitive presence is the socially constructed knowledge created by members of the group.

COLLABORATIVE PROBLEM-SOLVING WITHIN THE CPSA

The construct of CPS is firmly embedded into the CPSA through the sections of the rubric labelled problem-solving and teamwork. Both of these skills stem directly from ABET's CAC student outcomes and have been slightly modified within the CPSA. The CPSA versions have been adapted to read as learning outcomes [16].

The CPSA rubric itself includes an expanded definition of the learning outcome, a set of criteria used for assessment, and descriptors that are scored: 0 - missing, 1- emerging, 2 - developing, 3 - practicing, 4 - maturing, 5 - mastering. The target score for 3rd year students in this study is 3.0, because there is moderate alignment between years of study from first year (1.0) all the way through to masters (5.0).

For CPSA 1, which addresses problem-solving, the expanded definition reads as …*Students define and differentiate between the problems raised in the scenario with reasonable accuracy. Students recommend potential non-technical and technical solutions from a computing perspective. Students identify relevant stakeholders and explain their perspectives.* The three criteria to which ratings are given before being merged into an overall score are *problem identification, recommendations for solutions* and *stakeholder perspectives.* The appropriateness of these criteria are that problems need to be correctly identified before an appropriate solution can be proposed, and the perspectives of stakeholders demand that alternative points of view need to be recognised as these will enhance both problem identification and the solutions that are put forth.

For CPSA 2, which addresses teamwork, the expanded definition states: …*Student discussion is guided by the prompts. Students interact in a group setting by acknowledging, building on, clarifying and/or critiquing each other's ideas* (note: prompts are the questions supplied to students to guide the discussion to complete the task). The two criteria emerge directly from the definition as *prompts* and *discussion* represent staying on task and effective engagement amongst team members. Through assessment of the problem-solving and teamwork learning outcomes, the skill attainment level of CPS can be clearly measured within the CPSA.

METHOD

This study had 24 participants from a 3rd year undergraduate course in IT project management. Though this course was conducted in a traditional face-to-face environment, the work and feedback provided by the students was all completed as an on-line assignment. The primary goal of the study was to assess student performance in the skill of CPS, and the secondary goal was to learn how students felt the assessment task did or did not help them become more proficient in the skill of CPS.

To achieve the first goal, five groups of 4-5 students participated in an asynchronous on-line group discussion using the CPSA. Their task was to work together in order to develop recommendations for solutions to an ill-structured, complex and open-ended problem - typical of problems faced in the workplace. The CPSA performance task is implemented over a 12 day period, where student groups are required to read and discuss the scenario in order to put forth meaningful recommendations as to how the problem posed in the scenario could be solved. In order to enhance student familiarity and comfort with the task conducted as an asynchronous on-line discussion, a complete pilot run of the activity is completed with students before they are formally assessed in a subsequent run. To ensure the pilot run is meaningful to the students, strengths, weaknesses and best practices from the student discussions are examined and discussed as a class.

To achieve the second goal, all of the students completed an anonymous two-part survey with eight Likert-scale items and three open-ended questions about their perceptions of the activity. The Likert-scale items have been adapted from the Australian course experience questionnaire in that the word *course* has been changed to *activity* [17]. The Likert-scale items were rated from 1 - strongly disagree to 5 - strongly agree. For the purposes of this study, only the 4 Likert-scale items pertaining directly to problem-solving and teamwork have been included, but all three of the open-ended items have been utilised since the responses are relevant.

ANALYSIS

Since there were two distinct phases (goals) in the method, there were two distinct phases of analysis. The initial phase focused on the discussion transcripts, and the second phase on the analysis of the survey. At conclusion of the discussion task, discussion transcripts were assessed at the group level by a trained group of faculty (staff) using the criteria presented in the CPSA rubric. For the analysis a consensus estimate approach was utilised to enhance inter-rater reliability amongst the trained faculty [18]. In this approach, a single transcript is rated by all raters, results are shared, and then any differences of greater than one score on the rubric are discussed. Using evidence from the transcripts, raters then work towards consensus. This process is applied to the ratings for the complete set of transcripts until consensus is achieved and scores do not differ by more than one point on the six-point scoring scale. This results in each group being given a score for problem-solving, teamwork and an overall score for CPS. Additionally, the percentage of scores at or above the target of 3.0 has been calculated for problem-solving, teamwork and CPS overall. The most appropriate descriptive statistics have then been applied to this data.

In the analysis of the survey, student responses to the open-ended questions were analysed through an iterative process, where the entire set of responses were read and re-read looking for emergent themes. Responses were then highlighted and labelled as a specific theme, re-read and either confirmed as a theme, changed to another theme or a theme itself was edited to better represent the texts. This was done for each of the open-ended response items until each of the responses was appropriately labelled and ready to be drafted into a descriptive narrative. In order to better represent the students' perspectives, direct quotations have been utilised in the narrative, but some of these have been edited for readability when deemed necessary.

RESULTS

In this study, ratings of the CPSA sections for problem-solving and teamwork serve to represent the construct of CPS. These scores are shown in Table 2 below. For problem-solving, the five student groups had a mean score of 2.6 with only 40% of the groups achieving the desired score of 3 (since a 3rd year class). With teamwork the mean score was 3.4 and all of the groups achieved the target of 3, so overall teamwork was the superior skill. The mean score of problem-solving and teamwork, the most accurate measure for CPS, showed that only two of the group mean scores were at or above the 3.0 threshold, but the overall mean was a 3.0 with 40% of groups at the expected 3.0. Groups 1 and 2 consistently outperformed the other three groups in both problem-solving and teamwork, and hence, CPS where they scored a 3.5 and 4.0, respectively. Though they performed well in teamwork, groups 3, 4 and 5 scored only 2.0 for problem-solving, thereby lowering their mean CPS scores to 2.5, which is below the target 3.0. First and foremost, problem-solving was inadequate and below expectations.

Table 2: Group ratings.

Group	Problem-solving	Teamwork	Mean (collaborative problem-solving)
1	3	4	3.5
2	4	4	4.0
3	2	3	2.5
4	2	3	2.5
5	2	3	2.5
Mean	2.6	3.4	3.0
CPSA % ≥ 3	40	100	40

Student perceptions provide important insights as to how students gauge whether the activity is enhancing their ability to collaboratively problem-solve. Three Likert-scale questions dealt with problem-solving, while only one covered working as a team. The mean scores for all four questions ranged from 4.08 to 4.54 (see Table 3), so considering that a score of 4 is agree and 5 is strongly agree, student perceptions of the efficacy of the activity to promote both problem-solving and teamwork is quite high. Only the item pertaining to confidence in tackling unfamiliar problems, were students much closer to agreement than strong agreement. Overall, the survey revealed that students were extremely positive about the activity.

Table 3: Student perceptions of the activity.

Item	Mean	SD
The activity helped me develop my ability to work as a team member.	4.46	0.64
The activity helped to develop my ability to analyse problems.	4.54	0.58
The activity helped to develop my problem-solving skills.	4.42	0.64
As a result of the activity, I feel more confident about tackling unfamiliar problems.	4.08	0.67

In addition to the Likert-scale items students were asked to respond to 3 open-ended items; 1) what I liked about the activity; 2) what I did not like about the activity; and 3) changes in the activity I would like to see. For the first open-ended response item - what I liked about the activity - there were a total of 519 words written for a mean post length of

21.6 words. The dominant theme that emerged was that students appreciated working as a team. Hence, this theme was labelled teamwork. A sub-theme to this has been labelled different peers, because the focus of the students was that they participated in teams with students with which they would not normally interact. For teamwork, students made comments, such as …*I like the cooperation between our group members, my group members were working as a team,* and …*it was useful to discuss with my group members online for 12 days.* The sub-theme, different peers, was closely related in that it was about teamwork, but it was specific to working with people that students would not normally work with.

Discussion board groups were randomly assigned, and this was positively received by this cohort of students. Representative statements were …*I worked with unknown people to me, it was fun because we met new people and worked together*, and …*we were able to discuss with unfamiliar people*. The second theme that emerged was that the task helped students solve the problems, so it was labelled as problem-solving. Given that this is the most important element of the task, it was reassuring that students felt that the task helped them solve problems. Two examples of student responses were that 1) *they learn how to solve the problems*, that it helps them to *define the problem and try to come up with solution*; and 2) *makes us think of different sides of the problem*. Finally, one student noted that using an asynchronous discussion board made them more comfortable, because they were able to carefully draft and compose their ideas which cannot occur in the immediacy of synchronous classroom communication.

Far less was shared in response to the second open-ended item - what I did not like about the activity - in that there was a mean length of 15.8 words. Of the responses, four students stated that they disliked nothing about the activity. The theme that was mentioned most frequently by students was labelled time. Brought up 9 times, students felt a pressure of being required to post on a regular basis. Comments such *as …I did not like the short intervals in which we had to post our answers to the discussion, most of the responses were rushed due to the time duration between each post* and that …*we have a specific time to send the post* were exemplars of this theme.

The next theme that emerged had to do with the logistics of a discussion board and was labelled confusion, because some students felt confused or that their team members were confused. One student wrote …*so many ideas were discussed, and I got confused which one I should talk about*, while two others felt that some team members did not follow discussion threads to let them come to a conclusion before moving on. This led to *posts looking unorganised*. In direct opposition to the earlier open-ended response item where students seemed to enjoy working with unfamiliar peers, one student wanted to have been able to choose their own group members.

With the third open-ended response item - changes in the activity I would like to see - posts had a mean length of 14.7 words. The most dominant theme which was shared six times was that there is no need to make any changes to the task. The next most prominent theme was directly related to the logistics theme from open-ended response two. In addressing this logistics theme, students provided suggestions as to how the discussion board could be operated. For example, students made constructive comments, such as …*longer intervals between posts would be beneficial to think more about the problems* and *I think it would be better if the time period between each post was extended* in order to improve their discussion board experience. Next, there were a few suggestions to either change the topics under discussion or let the groups select the topic themselves. Finally, one response that stood out from the others was a suggestion to conduct the *discussion in class with groups and discuss it with the instructor*. Of course, this would mean fundamentally altering the activity and eliminating it as an asynchronous online discussion leading to superficial analysis of the problem provided to the students to solve, and limiting the opportunity to develop the 21st Century skills the CPSA is designed to enhance.

DISCUSSION

The discussion is framed around answering the two research questions.

To answer the first research question - *what are the levels of student performance in skill of collaborative problem-solving?*, it is necessary to examine results of how student groups were scored on the problem-solving and teamwork sections of the CPSA rubric. Taken together these two skills present the overall level of student performance on collaborative problem-solving. When this is done, one can see that 40% of the groups attained at or above the 3.0 target, and that the combined mean score was exactly 3.0. While the mean score supplies evidence that student groups performed to the level expected for 3rd year students, the fact that 40% of groups attained the 3.0 shows that a majority (60%) of student groups did not meet the desired and expected threshold. Because of this, overall performance is mixed and points to the need to include more CPS opportunities within the curriculum for students to be able to enhance their CPS skillset.

For the second research question - *what are student perceptions of the task in helping them become more proficient in the skill of collaborative problem-solving?*, a very positive picture was presented through the closed and open response survey items completed by the students upon finishing the task. With Likert-scale item mean scores ranging from 4.08 to 4.54, students were overwhelmingly positive that the activity enhanced their ability, and this was supported through the open-ended responses. Though the three items did not specifically ask about problem-solving or teamwork, these were by far the dominant themes that students shared. Students repeatedly mentioned how they benefited from the teamwork aspect, including working with peers that they normally would not interact with regularly. The appreciation towards the collaboration in all likelihood led to strong feelings that participation in the task helped develop their problem-solving skills. A few critiques of the activity also emerged, but in most cases these were extremely limited and had to do to with

discussion board logistics and, of course, issues like time demands and a need for quick responses that are often part of successful collaborative problem-solving and project completion, e.g. meeting workplace deadlines. Overall, students were quite positive towards the activity, and they performed adequately. This lends support to the theoretical framework provided by social constructivism and shows that curricular modifications towards this type of pedagogy would be prudent in the desire to enhance students' ability to collaboratively problem-solve [14].

CONCLUSIONS

As has been noted …*whether it is in schools, at the workplace, or in our free time, we are constantly embedded in environments that require us to make use of social skills in order to coordinate with other people* [3], and this is often done to solve problems. Within the engineering and computing disciplines, problems are becoming increasingly complex and require the diverse talents of teams, if they are to be solved effectively and timely. Hence, the professional skills of teamwork and problem-solving that form the building blocks of CPS need to be taught and assessed in the curricula of these professions.

As Hesse et al and Gauvain have argued, it is not enough to expect students to reach their potential in CPS on their own or without meaningful instructional and curricular guidance [3][9]. Implementation of the CPSA provides the required structure that emphasises CPS and provides faculty and researchers valuable evidence-based insights into student performance of this essential 21st Century skill.

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REFERENCES

1. Schoepp, K., Danaher, M., Rhodes, A. and Ater Kranov, A., Assessing teamwork in a computing programme. *World Trans. on Engng. and Technol. Educ.*, 17, **1**, 29-34 (2019).
2. Zhang, J., A distributed representation approach to group problem solving. *J. of the American Soc. for Infor. Science*, 49, 801-809 (1998).
3. Hesse, F., Care, E., Buder, J., Sassenberg, K. and Griffin, P., *A Framework for Teachable Collaborative Problem Solving Skills*. In: Assessment and Teaching of 21st Century Skills. Dordrecht: Springer, 37-56 (2015).
4. Zou, T.X.P. and Mickleborough, N.C., Promoting collaborative problem-solving skills in a course on engineering grand challenges. *Innovations in Educ. and Teaching Inter.*, 52, **2**, 148-159 (2015).
5. Accreditation Board for Engineering and Technology. Criteria for Accrediting Computing Programs, 2017-2018. (2018), 3 July 2018, http://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-computing-programs-2017-2018
6. Passow, H.J. and Passow, C.H., What competencies should undergraduate engineering programs emphasize? A systematic review. *J. of Engng. Educ*., 106, 475-526 (2017).
7. Mardis, M.A., Ma, J., Jones, F.R., Ambavarapu, C.R., Kelleher, H.M., Spears, L.I. and McClure, C.R., Assessing alignment between information technology educational opportunities, professional requirements, and industry demands. *Educ. and Infor. Technologies*, 23,**4**, 1547-1584 (2018).
8. Misra, R.K. and Khurana, K., Employability skills among information technology professionals: a literature review. *Procedia Computer Science*, 122, 63-70 (2017).
9. Gauvain, M., Collaborative problem solving: social and developmental considerations. *Psychological Science in the Public Interest*, 19, **2**, 53-58 (2018).
10. Rummel, N. and Spada, H., Learning to collaborate: an instructional approach to promoting collaborative problem solving in computer-mediated settings. *J. of the Learning Sciences*, 14, **2**, 201-241 (2005).
11. Ater Kranov, A., Danaher, M. and Schoepp, K., A direct method for teaching and measuring engineering professional skills for global workplace competency: adaptations to computing at a university in the United Arab Emirates. *Proc. 2014 IEEE Inter. Conf. on Interactive Collaborative Learning*, Dubai, UAE, 29-36 (2014).
12. Danaher, M., Schoepp, K. and Rhodes, A., Reliability and validity of the computing professional skills assessment. *Global J. of Engng. Educ.*, 21, **3**, 214-219 (2019).
13. Danaher, M., Schoepp, K. and Ater Kranov, A., Are students in graduate programmes adequately attaining professional skills? *World Trans. on Engng. and Technol. Educ.*, 15, **4**, 311-316 (2017).
14. Vygotsky, L.S., *Mind in Society: the Development of Higher Psychological Processes*. Cambridge, Mass: Harvard University Press (1978).
15. The Community of Inquiry, 15 April 2018, https://coi.athabascau.ca/
16. Schoepp, K., The state of course learning outcomes at leading universities. *Studies in Higher Educ..*, 44, **4**, 615-627 (2019).
17. Australian Course Experience Questionnaire (CEQ) (2015), 1 June 2015, http://www.graduatecareers.com.au/research/surveys/australiangraduatesurvey
18. Schoepp, K., Danaher, M. and Ater Kranov, A., An effective rubric norming process. *Practical Assessment, Research and Evaluation*, 23, 11 (2018).

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