Evaluating the Alignment Between the RSD Framework and the Effectiveness of 'Bolted on' Research Skills Training

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Abstract

This research considers the alignment of the curriculum and assessment design of the subject *Research and Communication Skills for the Natural Sciences* (*SC5055) against the RSD matrix and asks which students benefit most from training in research and communication skills. The impact of SC5055 on students' achievement and their ability to self-evaluate the development of their skills and understanding is also explored. Potential improvement for the RSD framework is highlighted.*

Introduction

Research skills training is a focus of interest in higher education not only for students aspiring to be the producers of new knowledge and understandings but also for those who will access and use such new knowledge and understandings in the course of their professional activities. Critical thinking and written communication skills underlie almost every stage or component of the research endeavour [1, 2, 3]. But, while critical thinking is much discussed, clear definitions of what it is, how it may be developed, practiced and assessed, are seldom clear [1, 4]. In research training, the importance of the linkages between the development of critical thinking skills and critical reflection or reflective judgement, including reflection and judgement on one's own development, is even less understood.

At James Cook University the overwhelming majority of candidates in the Master of Science (Coursework) program expect to complete a minor thesis and then progress to a higher degree by research candidature. The subject SC5055:03 '*Research and Communication Skills in the Natural Sciences*' (from hereon SC5055), was purposed to hone the research and, in particular, research communication skills of postgraduate coursework students. As part of their research training agenda, many Australian universities offer research methods subjects, focusing on the multiple facets of research communication as a key skill. This emphasis is due to the expectations that graduates of masters and doctoral degrees will author and co-author reports and research papers, propose new research, apply for funding, and be able to participate in the peer review

process [5, 6]. Furthermore, higher order thinking skills – critical thinking and reflective thinking – are prerequisites for the unambiguous and effective communication that is expected by employers and academia alike.

Here, we present exploratory research that considers

1) the alignment of the curriculum and assessment design of SC5055 against Willison's RSD matrix [7],
2) which students benefit most from training in research and communication skills, and
3) the impact of SC5055 on students' achievement and their ability to evaluate the development of their own skills and understandings.

Academic setting

At JCU, the majority of postgraduate students use the MSc (coursework) as a pathway to the PhD. Hence, an introductory subject in research methods and communication was seen as an efficient platform to teach, practice and assess critical thinking, critical reflection and science communication skills. The teaching team was challenged to engage a highly diverse body of students with strikingly variable English language skills and with limited exposure to research and research training. Most students have had no or minimal exposure to issues related to the responsible conduct of research. Further, students had highly variable and narrowly focused research interests. As noted previously [8], most students exhibited significant resistance to "wasting time" on learning research and communication skills.

Subject delivery, curriculum and assessment

Offered as a limited attendance, blended learning class, SC5055 was compulsory for all students in the MSc (Coursework). Prior to attending scheduled classes, students were presented with an e-folder containing learning resources and preparatory tasks to be completed.

Assessment consisted of an original research proposal (40% of total marks), an oral communication piece (30%, and not discussed further in this paper) and a learning portfolio (30%) that required self-evaluation of the development of skills relevant to subject learning outcomes [9]. The preparation of these assignments was scaffolded by four workshops, plus two two-hour tutorials bookending the semester. Throughout, team work and collegiality amongst students was stressed.

At first, students were introduced to the functions and format of scientific research proposals and to topics on the responsible conduct of research. The level of autonomy expected paralleled level 4 of the five-point RSD framework, with students directed to observe the guidelines of the JCU Rising Stars Leadership program (see https://www.jcu.edu.au/research/i-want-to/grants/internal-grant-schemes/research-

services). The proposal was graded twice. The first submission was graded and commented on by staff and was peer reviewed by at least two fellow students. Students gave and received peer reviews during and following the second workshop that was focused on critical reading and writing [10]. The process of writing an original research grant application fully engaged students with the facets of the RSD framework. This included ethical issues as they relate to research using human or non-human subjects as well as the ethics around peer review and authorship (Table 1).

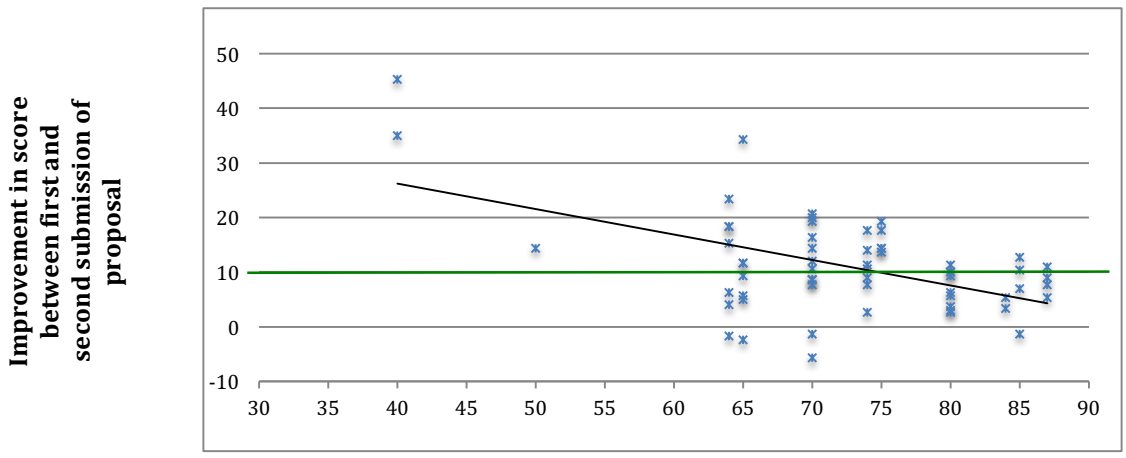
Table 1. Alignment of RSD level 4 indicators and assessment criteria for the research proposal, one of the major assignments for SC5055. Numbers in brackets in column three denote correspondence with RSD facets, also numbered.

Facets of RSD framework	**Level 4 indicators**	**Alignment to indicators (made evident by assessment criteria below)**
1. Embark & Clarify	Students generate questions /aims/ hypotheses framed within structured guidelines. Anticipate & prepare for ECST issues	• The research question is clearly original and fits clearly within Australian and New Zealand Standard Research Classification Codes and research type. **(1)** • Ethics and safety issues are considered and are appropriate and comprehensive for the research **(1,6)** • The methodology is appropriate to address the research question. **(2)** • The proposal has a clear project description that includes why the work warrants funding based on the identification of a knowledge gap or contradiction, innovative research and very clearly defined outcomes and outputs. **(2, 3, 4, 5)** • The budget is fit for the purpose of the proposed research and is tightly
2. Find & Generate	Students collect & record self-determined information/data choosing an appropriate methodology based on parameters set.	
3. Evaluate & Reflect	Students evaluate information/data & the inquiry process using self-determined criteria developed within parameters given. Reflects to refine others' processes	
4. Organise & Manage	Students organise information/data using self-determined structures, & manage the processes (including team function) within the parameters set.	
5. Analyse & Synthesise	Students analyse	

	information/data & synthesize to fully integrate components, consistent with parameters set. Fill knowledge gaps that are stated by others	aligned with proposed research methods. **(4)** • Track record and leadership, relative to opportunity, are clearly articulated. **(5)**
6. Communicate & Apply	Students use discipline-specific language & genres to demonstrate scholarly understanding for a specified audience. They apply the knowledge developed to diverse contexts and specify ECST issues in initiating, conducting & communicating.	• Alignment to university strategic intent made clear. **(5)** • The project has a clear objective and the summary is well articulated for the layperson. **(6)** • Quality of writing, observance of guidelines and presentation. **(6)**

Performance of the 2015 student cohort

To examine the effectiveness of SC5055 on students' achievement we took the formative and summative grades obtained for their research proposals. We considered that the difference in grade between the two reflected the impact of engaging with SC5055. Of the 61 students who submitted work for both the formative and summative assessments, 5 students' summative grades were below the formative grade (i.e. below 0 on the 'y' axis), while 32 students improved by 10 marks or more (Figure 1). Students obtaining failing grades for their first submission made the greatest improvement. All 6 students who improved by ≥20 marks scored ≤70 marks for their formative grade (Figure 1), implying that weaker students benefited the most from instruction on proposal writing and critical reading and writing coupled with the extensive feedback provided (Pearson's r=0.52, P<0.001).



Proposal score, first submission

Figure 1. Improvement in the research proposal score (vertical axis) as a function of student's formative score (horizontal axis). The 10-point improvement is highlighted in green.

We then probed to see whether students showing the most improvement were more aware of their learning experience than were students who displayed less improvement. We took the grades obtained for the reflective learning portfolio as a proxy measure of students' ability to understand their own learning and correlated those with the scores for the first submission of the proposal (Figure 2a) and with the improvement in scores between the two submissions (Figure 2b). To address issues of validity and reliability [11], the portfolio consisted of 4 individual reflective pieces and was assessed by 4 different academic teaching staff.

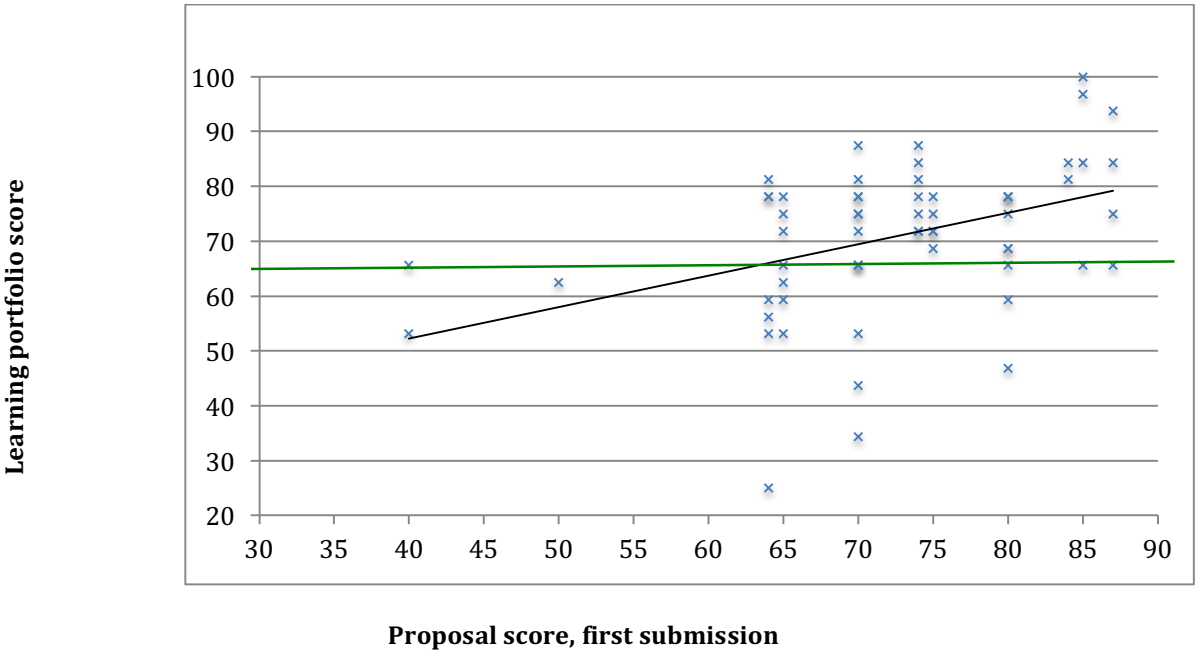


Figure 2a. Scores on learning portfolio as a function of student's grade for the first submission of the research proposal). Students scoring above 65% (green line) gained grades of Credit, Distinction or High Distinction.

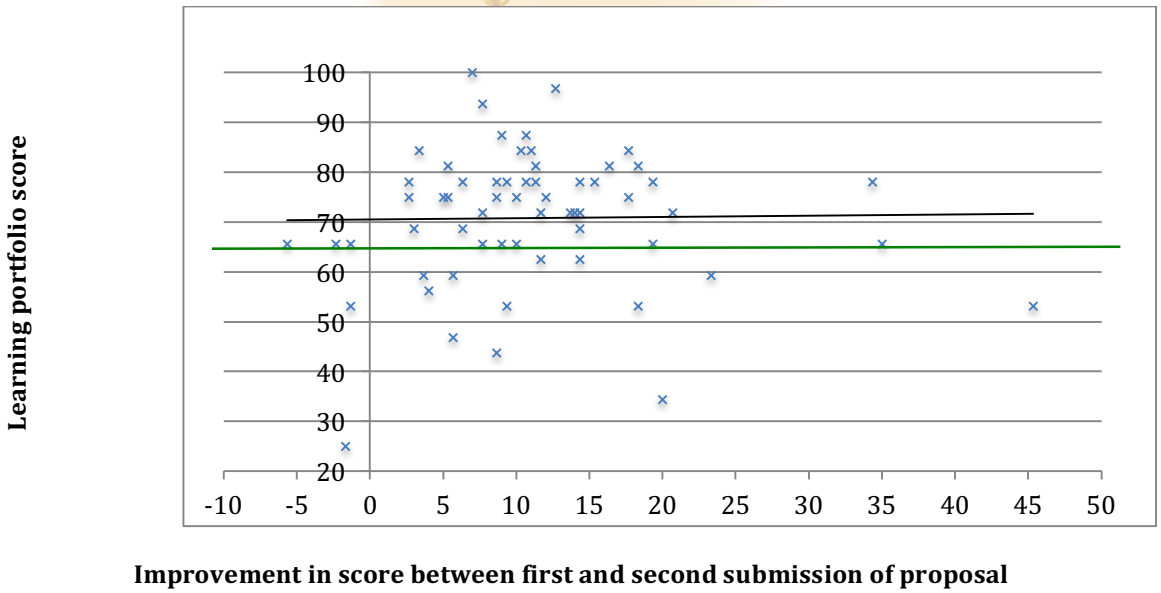


Figure 2b. Scores on learning portfolio as a function of student's improvement in the research proposal. Students scoring above 65% (green line) gained grades of Credit, Distinction or High Distinction.

Students' ability to think about their own learning processes was only weakly associated with their scores for the first submission of their proposal (Fig. 2a) (Pearson's r=0.41, P<0.001) and, importantly, there was no relationship between the improvement achieved for the second submission and the learning portfolio score (Fig. 2b) (Pearson's r=0.003, P=0.98). This leads to the supposition that a large proportion of students, irrespective of initial performance and improvement, are lacking awareness of their own learning, and that the process of writing the learning portfolio failed to make explicit the mental models and skill awareness, which is an alleged benefit of writing reflective essays and learning portfolios [8].

While it is well known that future performance is quite reliably predicted by past performance, past performance is often a poor predictor of *improvement* in performance [12]. This is attributed to the performance heuristic, meaning that instead of critically examining the potential for future improvement in performance, people expect future success or failure to be commensurate with their past performance. Such expectations prevent insights into factors that can shape future performance. This could explain why students with a poor initial performance for the proposal tend to fail to understand their subsequent improvement and show limited awareness of learning and development, scoring low for the learning portfolio. Many others, performing relatively highly in the proposal, also demonstrated poor awareness of their skills and learning. This has the potential to significantly diminish the effectiveness of RSD programs, and the omission by the RSD framework of the ability to critically reflect on one's own development needs addressing.

Given the lack of any relationship between the portfolio score and the improvement achieved for the second submission of the proposal (see Figure 2b), how does one account for the observation that students scoring lower in the first submission tended to show the most improvement for the second submission? There are several possible explanations for this. Firstly, some students, disappointed with their formative grades, may simply seek the assistance of academic study skills advisors and, after implementing the advice given, obtain a much-improved grade for their second submission. In this case low grades would be expected for the portfolio. Others, satisfied with their formative grade and relying on the performance heuristic, would expect an equally satisfying grade for the second submission, thus limiting their improvement and scoring low for the portfolio (Fig. 2a). The lack of demonstrated relationship between reflective thinking and academic performance [13] would also explain the widespread of scores for the portfolio amongst students gaining a distinction or high distinction for the first submission of the proposal (see Figure 2a). Furthermore, and as noted by Hosein and Rao [8], it is uncertain if the marking criteria scaffolded the reflective writing of the more academically sophisticated students, that is, those receiving scores >80% for the formative proposal and scoring highly in the portfolio.

This exploratory research scoped the relationship between students' research skills, as expected according to level 4 of the RSD framework, and their ability to reflect on their development of knowledge and skill. Many students, while achieving much improvement in their assessment score, seem unaware of the processes that allowed them to improve. We need to equip students with the skills to be competent, self-regulated learners, understanding and practicing the metacognitive skills that allow them to perform at *their* highest level. This is especially important in research training as reflecting on and understanding the reasons for success or failure in the research endeavour is a critical attribute of accomplished researchers.

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