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Keywords

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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.

Written communication and critical thinking skills underlie almost every stage or component of the research endeavour (Dwyer et al. 2014; Ghanizadeh 2017; Moore & Morton 2017) and proficient researchers need to excel in both. Writing practice is widely believed to be essential in developing not just communication skills but also skills in critical thinking and scientific reasoning (Dowd et al. 2018). At the same time, audience-focused communication skills are increasingly key to the acquisition of research funding, public engagement and the building and maintenance of multidisciplinary teams. For these reasons, expertise in communicating to a wide range of audiences is a highly valued and complex (Proske et al. 2012) skill. Expert academic writers achieve a high level of proficiency as a result of many years of practice and engagement. While acquisition of written communication skills in particular is central to a student's academic development, explicit promotion of this required expertise remains wanting in higher education (Proske et al. 2012; Wischgoll 2016).

Similarly, while critical thinking is broadly understood as a disciplined intellectual process of synthetising or evaluating information, or bringing reasoned judgement to an argument (Wilson Mulnix 2012; Geng 2014), clear definitions of what critical thinking is and how it may be developed, practiced and assessed among a variety of learners are seldom made explicit (Wilson Mulnix 2012; Dwyer et al. 2014; Cargas et al. 2017). Wilson Mulnix (2012, p. 473) concludes that:

> *…the fundamental skill to be acquired by a critical thinker is the ability to recognise inferential connections holding between statements, where this would include the ability to understand the possibility that what we believe might be false and the ability to identify the sorts of evidence that would undermine our belief.*

Although van Gelder (2005) suggests that critical thinking can be taught, the design of subjects and courses that foster students' development of these skills and attitudes remains challenging for academic staff (van Gog et al. 2005). Most academic staff are not practiced in linking explicitly the development of critical thinking and writing skills – the outcomes of learning – and the development of critical reflection or reflective judgement, including reflection and judgement on students' own learning and development – the process of learning (Harper & Orr Vered 2017; Martin 2018). The research literature on how academic writing is learnt (Sala-Bubare & Castello 2018) is vast and diffuse, and assumes considerable prior knowledge from the reader. It is therefore not surprising that university teaching staff with their research focus on, for example, ecology, economic geology or urban design, have not made much use of that body of research to inform their teaching (Martin 2018).

Drawing from research on skills acquisition, several authors (van Gelder 2005; van Gog et al. 2005; Proske et al. 2012; Wilson Mulnix 2012) emphasise that for students to develop proficiency

as critical thinkers and effective writers, they must engage in deliberate practice as opposed to repetitive practice. It is understood that deliberate practice facilitates development of expertise in a skill or a set of skills through the maintenance of high levels of conscious monitoring and control (Ericsson et al. 1993). Fundamental to critical thinking is the learner's awareness of and responsibility for their own thinking processes and to develop reasonable criteria for monitoring and evaluating their own thinking (Ghanizadeh 2017). Successful postgraduate students, early career researchers and other professional workers must develop the habit of mind to identify their own learning needs for improvement, then plan, monitor and evaluate their progress (van Gog et al. 2005).

When designing subjects and courses that could foster deliberate practice, learning exercises need to be individualised, clearly defined and authentic (van Gog et al. 2005). This means that tasks and activities that are intended to improve skills should be representative of the entire skill, and must have well-defined performance criteria matched to expected levels of expertise. Van Gelder (2005) further adds that to enable students to engage in deliberate practice, close guidance and accurate and timely feedback on performance needs to be provided. The Research Skill Development (RSD) matrix (Willison & O'Regan 2006/2018; see the first article in this issue) clearly identifies performance criteria at different levels of expertise within the domain of academic research and is therefore a valuable resource when designing meaningful learning experiences for research skill training. While the RSD framework helps educators to design tasks and assessments that are appropriate for expected levels of learners' development, it is not a framework designed to advise on *how* to facilitate learners' deliberate practice and subsequent achievement of expected levels of performance.

As a general approach, inquiry- or research-based learning and teaching is demonstrably more effective than expository approaches for the teaching of critical thinking and writing (Tiwari et al. 2006). But no universal statements can be made about how to best support and guide learners in subjects or courses structured as research-based learning (Lazonder & Harmsen 2016) while enabling students' deliberate practice.

This exploratory research focuses on a one-semester subject that used a research-based approach to learning and was designed to facilitate deliberate practice while developing postgraduate students' basic research skills: academic writing and its co-requisite skill, thinking critically. The research considers:

1) the alignment of the curriculum and assessment design of subject SC5055:03 '*Research and Communication Skills for the Natural Sciences'* against Willison's RSD matrix (Willison & O'Regan 2006/2018),
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 self-evaluate the development of their skills and understandings.

Institutional and Academic Setting

At James Cook University (JCU), the overwhelming majority of candidates in the Master of Science (Coursework) program expect to complete a minor thesis to partially satisfy the requirements of admission to a higher degree by research candidature. The subject, SC5055:03 '*Research and Communication Skills in the Natural Sciences*' (from hereon SC5055), was a core component of the Master of Science (Coursework) program. 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 various research methods subjects, many focusing on the multiple facets of research communication as a key skill. This emphasis is due to the expectations that graduates of master's 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 (Cargill & Smernik 2016; McCarthy & Dempsey 2017). 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 (The Conference Board 2006).

Because the majority of postgraduate students at JCU use the MSc (Coursework) as a pathway to a PhD, an introductory subject in research methods and communication was seen as an efficient platform (Dowd et al. 2015) 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 yet narrowly-focused research interests. In keeping with other teachers' experiences (Hosein & Rao 2017), most students exhibited significant resistance to "wasting time" on learning research and communication skills.

Subject Delivery, Curriculum and Assessment Design

Offered as a limited attendance, blended learning class, SC5055 was a requirement for all students in the MSc (Coursework). The subject constituted three credits of the 18-credit degree program. Students were required to attend a two-hour introductory orientation session where the rationale of the subject content and the approach to learning and teaching were explained. This was followed by four workshops, each of four-hour duration. Finally, a two-hour session bookended the semester in the form of a questions and answers forum, which was designed to assist students in the preparation of the final piece of assessment. Students received a total of 20 face-to-face contact hours. Throughout the semester, the teaching team was available on demand for consultation by individual students or groups of students. The subject was managed using the LearnJCU Blackboard+Learn management system. Attendance during all contact hours was compulsory. Each of the five members of the teaching team was research-active, with a considerable track record in marine biology and aquaculture (2), physical geography (2) and environmental social science (1).

Curriculum and assessment were designed to promote the deliberate practice (Ericsson et al. 1993) of critical thinking and writing skills. Assessment consisted of an original research proposal (40% of total marks), an oral communication piece (30%, and not a focus of this paper) and a learning portfolio (30%) that required self-evaluation of the development of skills relevant to subject learning outcomes (Zubizaretta 2008; Nilson 2013). The assessment items, taken together, satisfied the indicators of teaching critical writing for the promotion of deliberate practice as follows. Assessments were individualised by allowing students to choose any topic as the subject of their proposal. Together, the assessment tasks were representative of the entire skill. Cognitive load was minimised by allowing the same topic to be developed for both the proposal and the oral communication piece, thereby allowing students to focus on the *process* of scientific writing and thinking critically and focus on regulating their own writing (van Gog et al. 2005) rather than struggle to acquire and hold in working memory new information about a number of different

research topics. Assessment tasks were clearly defined, with performance criteria and performance indicators made available (See Tables 1 and 2). Tasks and assessments were appropriate to the students' expected developmental level, as guided by the RSD framework (Willison & O'Regan 2006/2018) and the Australian Qualifications Framework (2013). In addition, to document development and understanding of their own learning, students were encouraged to utilise in their learning portfolio, as artefacts, the written assignments submitted for up to a year previously in other subjects. This design element was intended to demonstrate recursiveness and transferability of critical thinking and writing skills and to move students towards a conscious awareness of the cognitive and metacognitive challenges and triumphs experienced on their learning trajectories.

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 aligned with proposed research methods. **(4)** • Track record and leadership, relative to opportunity, are clearly articulated. **(5)**
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. Reflect 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 & synthesise to fully integrate components, consistent with parameters set. Fill knowledge gaps that are stated by others.	
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)**

Table 2. Performance indicators used for scoring the learning portfolio assessment criterion 'Elements of Reflection'.

Levels of performance	Performance indicators of 'Elements of reflection'
Very well developed	Reflection clearly and systematically describes, analyses and synthesises student's development and current level of proficiency; future actions clearly appropriate to personal goals; clearly cites strong and appropriate evidence found in the artefacts for all observations and to support all evaluative judgements; clear linkages between suggestions for growth and improvement and present skills and knowledge. Citing works of others as appropriate.
Well developed	Reflection describes, analyses and synthesises student's development and current level of proficiency; future actions appropriate to personal goals; cites appropriate evidence found in the artefacts to illustrate most observations and to support most evaluative judgements; linkages between suggestions for growth and improvement and present skills and knowledge are present but not as strongly and clearly as in the 'very well developed' category. Citing works of others as appropriate.
Acceptable	Reflection describes, analyses and makes some attempt to synthesise student's development and current level of proficiency; future action superficially appropriate to personal goals; cites mostly appropriate evidence found in the artefacts to illustrate most observations and to support most evaluative judgements; weak linkages between suggestions for growth and improvement and present skills and knowledge. Some appropriate citations of others' works.
Needs a lot more work	Reflection vaguely or inconsistently describes student's development or current level of proficiency or plans to improve; reader has some difficulty verifying the presence of appropriate evidence that illustrates observations and to support evaluative

	judgements; if present, suggestions for growth and improvement are platitudinous and not well linked to present skills and knowledge. Missing or haphazardly citing the works of others.

Prior to attending each workshop, students were presented with an e-folder containing guidance for learning and preparation for each workshop. Guidance consisted of online lecturettes, presentations, modelled problem solutions and written instructions for preparatory tasks on which in-workshop activities were built. Follow-up learning tasks were suggested at the conclusion of workshops. The final assessment item, the learning portfolio, was due for submission two weeks after the conclusion of the 14-week semester. It was intended that students re-examine their skill development and thus consolidate deliberate practice as an approach to learning. Feedback on performance was provided within three weeks of submission of work, in line with JCU learning and teaching policy. Throughout, teamwork and collegiality amongst students was stressed, to mirror the cooperation among practicing scientists.

The first workshop introduced students to the functions and format of writing scientific research proposals and to topics on the responsible conduct of research. The level of autonomy expected in developing proposals paralleled level 4 of the five-point RSD framework. Students were 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) thus giving authenticity to this task. The process of writing an original research grant application fully engaged students with each skill facet 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). 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. Assessment of the first submission was considered as formative insofar as it was used to feed back to students the strengths and weaknesses of their work. Accordingly, comments from staff were provided under the following headings: 1) overall grade for the effort, 2) the three best aspects of the work and 3) the three most important things to work on. While staff were assessing the first submission, students engaged in reciprocal feedback during and following the second workshop, which focused on skills of critical reading and writing and reviewing scientific papers (Gyuris & Castell 2013).

Performance of the 2015 Student Cohort

To examine the effectiveness of SC5055 on students' achievement, I calculated the difference between the formative and summative grades obtained for each student's research proposal. I considered that the difference in the grade between the two would indicate the impact of engaging with SC5055 up to the stage of the second submission of the proposal. This period included nine weeks of the 14-week semester. Of the 61 students who submitted work for both the formative and summative assessments, five students' summative grades were below the formative grade (i.e., below zero on the 'y' axis), while 32 students improved by ten marks or more (Figure 1). Students who had failing grades for their first submission made the greatest improvement. All six students who improved by ≥20 marks scored ≤70 marks for their formative grade (Figure 1), implying that weaker students benefitted the most from instruction on critical reading and writing coupled with the extensive feedback provided. Improvement between the first and second submission of the proposal score was negatively correlated with the score obtained for the first submission of the proposal (See Figure 1, Pearson's $r=0.52$, $P<0.001$). Students scoring 75 marks or above for their

first submission also improved their scores for the second submission, many by more than ten marks, demonstrating the value of instruction and feedback.

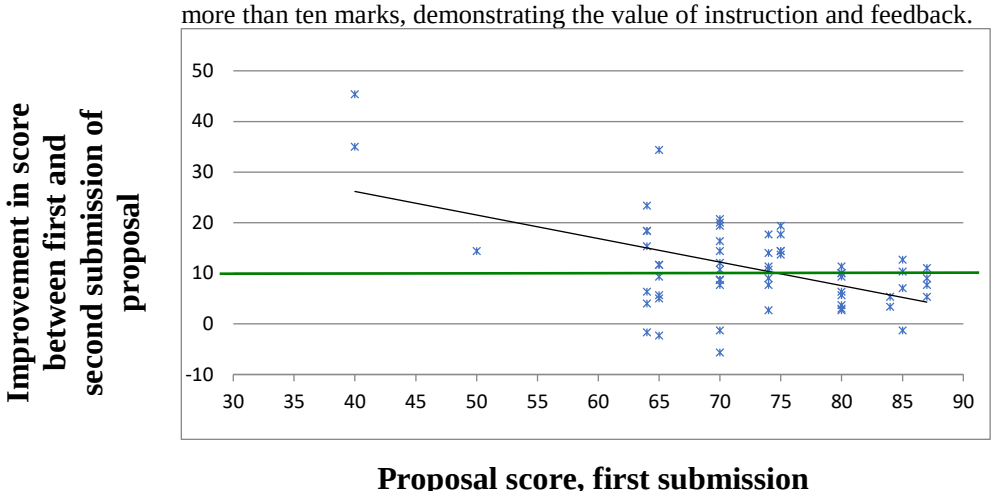

Figure 1. Improvement in the research proposal score (vertical axis) as a function of student's formative score (horizontal axis). The 10-point improvement is highlighted in green.

I then probed to see whether students showing the most improvement were more aware of their learning experience than were students who displayed less improvement. I 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 the issue of reliability of the portfolio grade (Moniz et al. 2015), the portfolio consisted of four individual reflective pieces and was assessed by four different academic teaching staff, each assessing one of the four pieces. The portfolio grade was the arithmetic average of the four marks thus obtained. Table 2 details the assessment criteria and performance indicators for the learning portfolio.

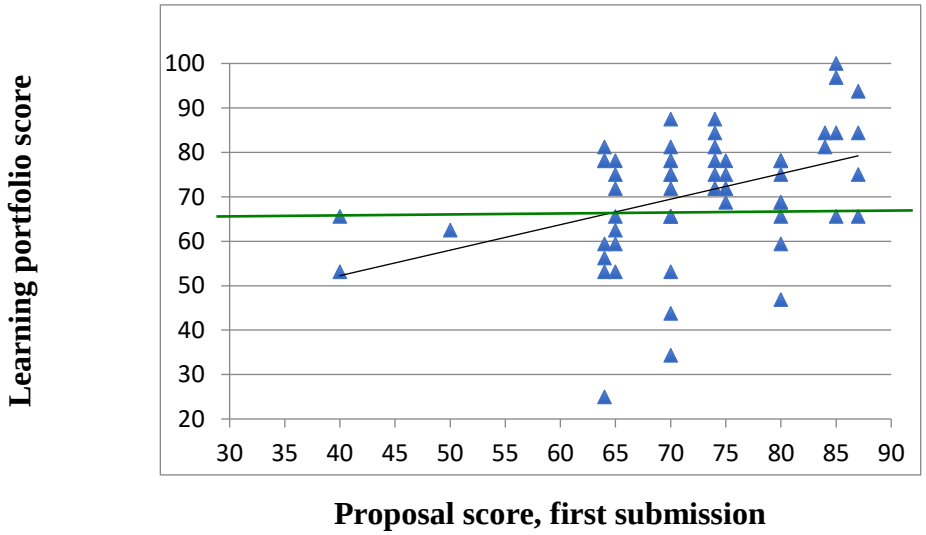

Figure 2a. Scores on learning portfolio as a function of student's grade for the first submission of the research proposal. Students scoring above 65% (green line) gained grades of Credit, Distinction or High Distinction.

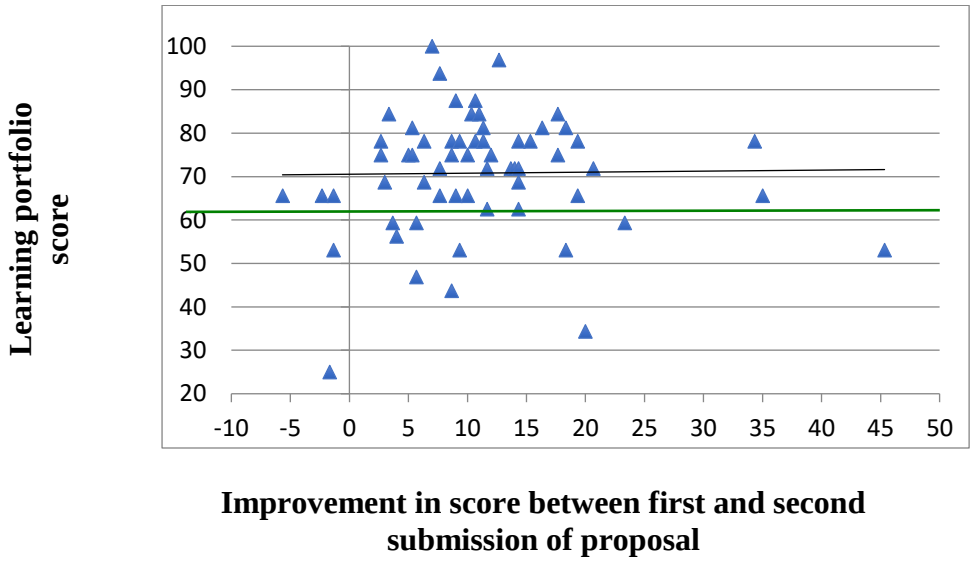

Figure 2b. Scores on learning portfolio as a function of student's improvement in the research proposal. Students scoring above 65% (green line) gained grades of Credit, Distinction or High Distinction.

Students' learning portfolio scores (used here as a proxy to gauge their ability to think about their own learning processes) were only weakly associated with their scores for the first submission of their proposal (Figure 2a) (Pearson's $r=0.41$, $P<0.001$) and, importantly, there was no observed relationship between the improvement achieved for the second submission and the learning portfolio score (Figure 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, were lacking awareness of their own learning, and that the process of writing the learning portfolio had failed to make explicit the mental models and skill awareness which are an alleged benefit of writing reflective essays and learning portfolios (Zubizaretta 2008; Hosein & Rao 2017).

Discussion

Most students demonstrated an improvement between the first and second submission of the research proposal. While some changes in scores were relatively small and may be the result of normal variation in the scoring process, the majority of students achieved a convincing and positive improvement. Students gaining lower scores for the first submission tended to show the highest gains for the second submission. Other studies have also observed that weaker students benefit most from instruction based on elements of deliberate practice (Ericsson et al. 1993; Gyuris & Castell 2013). It is also noteworthy that despite the potential ceiling effect, many scoring in the Distinction and High Distinction bands (75-84 and 85-100 marks respectively) for the first

submission also gained up to 10 marks for their second submission. This highlights the value of instruction, feedback and student engagement with the RSD matrix-driven task of writing the research proposal.

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 (Critcher & Rosenzweig 2014). 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, or an extension of, their past performance. Such expectations prevent insights into factors that can shape future performance. This could at least partially explain why students who had a poor initial performance for the proposal did not demonstrate in their portfolios an understanding of their subsequent improvement and awareness of learning and development, thereby scoring low for the learning portfolio. Many others, performing relatively highly in the proposal task, also demonstrated limited awareness of their skills and learning. Students' apparent lack of insight into factors affecting their own learning may potentially diminish the effectiveness of research skills programs.

While the RSD framework may be an excellent tool to prompt self-reflection for those who are already cognitively and metacognitively aware, it may be insufficient in its present form to *guide* students in the learning of skills for self-regulation or deliberate practice. It is important to note, however, that in SC5055, the RSD framework was primarily used to ensure that learning tasks and their assessment were appropriately pitched to the expected level of the students' research skill development. Students were not formally required to examine their levels of performance against the different levels of the RSD framework, and this could have limited, to some extent, the value of the framework. Yet, the RSD framework's omission of content explicitly addressing the metacognitive domain of development needs addressing if the framework is to aid the development of students as well as academic teaching staff.

Given the apparent lack of a 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 have sought the assistance of academic study skills advisors and, after implementing the advice given, obtained 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 as predicted by the performance heuristic, would have expected an equally satisfying grade for their second submission, thus limiting their improvement and resulting in a low score for the portfolio (Figure 2a). Secondly, the lack of demonstrated relationship between reflective thinking and academic performance (Phan 2008; Townsend & Heit 2011) would also explain the wide spread of scores for the portfolio amongst students gaining a Distinction or High Distinction for the first submission of the proposal (see Figure 2a). These observations seem to be in line with the findings of Brabeck (1983), who concluded that the development of reflective judgement is "separate from, and involves something other than, the acquisition of these [critical thinking] skills." Furthermore, and as noted by Hosein and Rao (2017), it is uncertain if the marking criteria scaffolded or prompted 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. A further possible response to the observed lack of relationship between the change in the proposal score and the portfolio score is to question the validity of the portfolio as a proxy for students' self-awareness of their learning. While portfolio assessments are well recognised as facilitating students' critical self-reflection on their

knowledge, skills and learning, Gregori-Giralt and Menendez-Varela (2015) detail three factors that can weaken the validity of portfolio-based assessments. They acknowledge that reliably excluding all three is a complex task, fraught with difficulties. The multiple possible reasons for apparent lack of awareness of learning highlight the need for research skills development programs to ascertain that students are able to develop and apply metacognitive skills successfully while preparing for their research careers.

Findings of this small scale, exploratory study also expose the potential lack of motivation, means or opportunity for students' deliberate practice of critical thinking and writing. The preconditions of deliberate practice require (a) that learners are motivated to exert effortful engagement with the task, (b) that the level of difficulty of the task is appropriate to learners' pre-existing command of the skill to be mastered, (c) that immediate and meaningful feedback about performance is provided, and (d) that learners repeatedly perform tasks requiring the same skill or skill set (Ericsson et al. 1993). The interaction between subject design, members of the teaching team, and the participating students may have inadvertently sabotaged one or more of these preconditions. The reluctance of students to accept the need to study research and communication skills *per se* could have undermined motivation in many. Selection of the research proposal as a major assessment item with a research topic freely chosen by students may have been ineffective to reverse such reluctance in many. The period between feedback and submission may have been too long and the quality of feedback in terms of detail and focus may have been lacking to some extent. Although students received explicit instruction and practice on reviewing scientific papers, prior to giving and receiving peer review on their first submission of the proposal, this reciprocal peer review may not have gained full engagement of the students and hence compromised its aims (Zhang et al. 2017; Santelmann et al. 2018). Improving the timeliness and quality of feedback is a perennial challenge for massified tertiary education. The close alignment between the RSD framework, the Australian Qualifications Framework (AQF) and the proposal as an assessment leaves no doubt about the appropriateness of the difficulty level of the proposal as a task to practice critical thinking and writing skills. With regard to the fourth precondition of deliberate practice, that is, repeated performance of tasks requiring the skill to be practiced, students were asked to observe their performance and feedback received on writing tasks (essays, laboratory reports, literature reviews, etc.) that they were completing in other subjects concurrently with or prior to receiving practice and instruction in SC5055. Instructions for how to develop a learning portfolio, including the collection of evidence to support observations about leaning and performance, were explicit, thereby providing a roadmap to effective deliberate practice of writing and thinking critically.

Development of the attitude for self-motivated deliberate practice is not easy. Even among medical residents, considered by many as amongst the most highly motivated and accomplished groups of adult learners, 50% lacked the skill of deliberate practice (Li et al. 2009). Deliberate practice is challenging, requires significant mental effort and individuals engaging in it rate it as less enjoyable then alternative activities. The gratification of improved performance is often delayed. Further, deliberate practice requires repetition and honest feedback, frequently from the learners themselves. Learners must recognise personal strengths and weaknesses and focus practice on skills that they judge to be limiting improvement in performance (Coughlan et al. 2013; Zhang et al. 2017). Feedback from teachers and mentors, and in particular reviewing and receiving reviews from peers, facilitates self-reflection (Santelmann et al. 2018) and promotes deliberate practice or its near-synonym, self-regulated learning (Zhang et al. 2017). Coughlan et al. (2013) further demonstrated that the quality of practice, rather than the hours of practice, was key to higher levels of attainment. While many students spend long hours gathering information and writing drafts, they do so mechanically and fail to pay attention to the quality of their study.

Consequently, their development plateaus long before they reach the level of thinking and writing skills that is expected from academic researchers. Self-regulation of learning or the habit of deliberate practice seems to be critical to achieve excellence in most skills and it remains a challenge for teaching academics to adapt the findings of educational psychology research to their own teaching practice. Furthermore, leadership in higher education in Australia needs to seriously facilitate a whole-of-degree, integrated-across-the-curriculum approach to the teaching of the most fundamental skill of writing driven by critical thinking (Harper & Orr Vered 2017).

This study is limited in scope, but it nevertheless documents an attempt to move critical writing and communication skills to the centre of the MSc (Coursework) program. The subject attempted to move from a service-based approach (Harper & Orr Vered 2017) to explicitly teach critical thinking and writing. The subject focused on learning not solely as a function of cognitive output (i.e., a written assignment) but also emphasised the process, or metacognitive development of learners. While the results of this study are not generalizable, it is hoped that the research will prompt further work to pursue any of the following themes: How and why do weaker students appear to gain the most from training in skills of critical thinking and writing? How to address many students' seeming lack of awareness of their own learning? And finally, how to extend the work of Gregori-Giralt and Menendez-Varela (2015) on finding practical ways to ensure that the writing of learning portfolios fulfils the benefit attributed to them?

Conclusion

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 proposal score, did not demonstrate in their portfolios an awareness of the processes that allowed them to improve. We need to equip students with the skills to be competent, self-regulated learners, so they can understand and practice 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 are critical attributes of accomplished researchers.

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